United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Andrew County, Missouri

How To Use This Soil Survey

General Soil Map

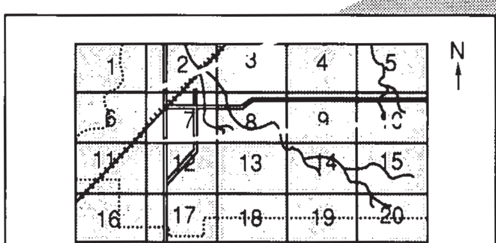
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



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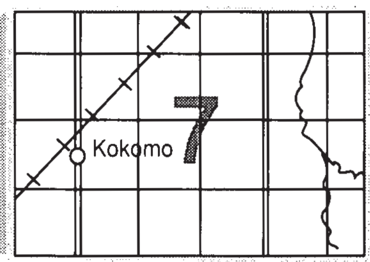
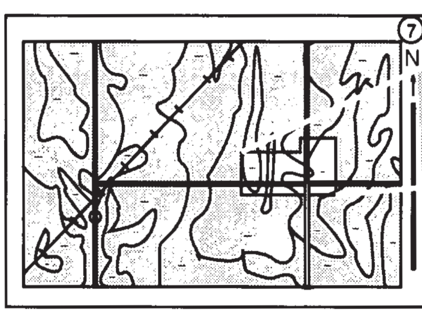


MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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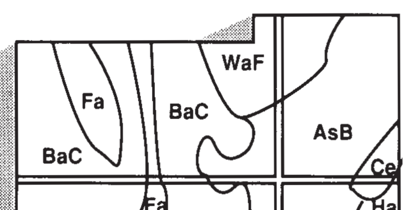

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1985. Soil names and descriptions were approved in 1986. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Missouri Department of Natural Resources provided a soil scientist to assist with the fieldwork. The Andrew County Commission provided office space for soil survey operations. The survey is part of the technical assistance furnished to the Andrew County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Well managed pasture of cool-season grasses in an area of the Marshall-Lamoni-Higginsville association.

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Foreword

This soil survey contains information that can be used in land-planning programs in Andrew County, Missouri. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of
Andrew County, Missouri

By Keith O. Davis, Soil Conservation Service

Fieldwork by Keith O. Davis, Soil Conservation Service, and Patricia A. Kowalewycz and Clayton E. Lee, Missouri Department of Natural Resources

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Missouri Agricultural Experiment Station

ANDREW COUNTY is in the northwestern part of Missouri (fig. 1). Savannah, the county seat, is 10 miles north of St. Joseph and about 50 miles north of Kansas City. The county has an area of 279,433 acres, or nearly 437 square miles.

This soil survey updates the survey of Andrew County published in 1925 *(10)*. It provides additional interpretative information and has larger maps, which show the soils in greater detail.

Figure 1.—Location of Andrew County in Missouri.

General Nature of the County

This section provides general information about Andrew County. It describes climate; physiography, relief, and drainage; history and development; and farming.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at St. Joseph, Missouri, in the period 1962 to 1979. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 29 degrees F, and the average daily minimum temperature is 19 degrees. The lowest temperature on record, which occurred at St. Joseph on January 12, 1974, is -25 degrees. In summer the average temperature is 76 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which

occurred at St. Joseph on July 13, 1954, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 34 inches. Of this, 24 inches, or more than 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 5.88 inches at St. Joseph on May 19, 1962. Thunderstorms occur on about 55 days each year. Tornadoes and severe thunderstorms occur occasionally but are local in extent and of short duration. They cause damage in scattered areas. Hail sometimes falls in scattered small areas during the warmer part of the year.

The average seasonal snowfall is nearly 21 inches. The greatest snow depth at any one time during the period of record was 18 inches. On the average, 10 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

Physiography, Relief, and Drainage

The landscape of Andrew County is mainly one of gently sloping to strongly sloping uplands. The Nodaway, 102, and Platte Rivers flow southward through the county. Between these rivers are narrow ridges and sloping hillsides dissected by small drainageways, which flow toward the larger streams. Bordering many of the areas along the major streams are rolling to steep hillsides. Limestone and shale formations crop out on the lower parts of the hillsides.

The northeastern part of the county has a distinctive broad ridge known as the "Empire Prairie." The southwestern part consists of rugged areas where thick deposits of loess overlie limestone and shale formations adjacent to the flood plains along the Nodaway and Missouri Rivers.

History and Development

Fertile soil, large timber tracts, abundant wildlife, and water attracted the early settlers to the survey area. Many of the first farmers were from Kentucky and Georgia. They had no experience in farming prairie land, so they settled in wooded areas, thinking that the soil would be more fertile than that of the prairie *(4)*. Most of them believed that the virgin prairie sod would be too difficult to break with the plow.

The first settlers came to the survey area in 1836. The area was then known as the "Platte Territory." By 1841, Andrew County was organized. The population of the county increased from 9,433 in 1850 to 16,318 in 1880 *(4)*. In about 1900, it peaked at just over 17,000. Since that time, it has gradually declined. In 1980, it was 13,980 *(15)*. In that year, the population of Savannah was 4,184.

Several small communities have important effects on the economy of the county. Their population has declined in recent years as members of the communities move closer to the larger towns for work. The railroads played an important role in the development of these communities. One still has an active line that runs through the county. The major thoroughfares that run north and south through the county are Highway 71, Highway 169, and Interstate 29.

Farming

The early settlers in Andrew County located mainly in wooded areas along the major streams. Game animals were abundant in these areas. The settlers raised a few cows, hogs, and chickens. Corn was the mainstay of the early farmers. Wheat, oats, and clover were the most common close-grown crops included with corn in the crop rotations. Before the Civil War, tobacco and hemp were important crops, and for a time cotton was grown to a limited extent for home use. In 1920, an average farm had 5 head of horses or mules, 7 milk cows, 14 other cattle, 89 hogs, 10 sheep, and 190 chickens *(10)*.

Farming currently is the main enterprise in the county. The chief crops are soybeans, corn, wheat, sorghum, and grasses and legumes. Beef cattle and hogs are the main kinds of livestock. The county also has a significant number of dairy cattle. The county had 1,008 farms in 1982 *(16)*. About half of the farmers

supplemented their income through off-farm employment.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of material in which the soils formed. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, soil reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic

classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally are in small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are named and mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately.

Soil Descriptions

1. Nodaway-Colo-Zook Association

Nearly level, moderately well drained and poorly drained soils formed in alluvium; on intermediate flood plains

This association is on flood plains along streams that are intermediate in size. The landscape is characterized by differences in elevation of only a few feet. Some areas have meandering river channels bordered by woodland. In places cultivated fields are directly adjacent to new channels.

This association makes up about 11 percent of the county. It is about 42 percent Nodaway soils, 30 percent Colo soils, and 28 percent Zook and similar soils (fig. 2).

Nodaway soils are moderately well drained and are in areas adjacent to the stream channels. Typically, the surface layer is very dark grayish brown, very friable silt loam about 7 inches thick. The substratum to a depth of 60 inches is friable silt loam. The upper part is stratified very dark grayish brown, grayish brown, and dark grayish brown. The lower part is stratified dark grayish brown and grayish brown and is mottled.

Colo soils are poorly drained and are in narrow upland drainageways and on small flood plains adjacent to the uplands. Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 31 inches thick. The subsoil also is black, firm silty clay loam. It is about 11 inches thick. The substratum to a depth of 66 inches is very dark gray, mottled, firm silty clay loam.

Zook soils are poorly drained and are in the intermediate areas between the stream channels and the Colo soils. Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is about 24 inches thick. It is black, firm silty clay loam in the upper part and very dark gray, firm silty clay in the lower part. The subsoil to a depth of 60 inches or more is very dark gray and dark gray, mottled, firm silty clay.

About 95 percent of the acreage in this association is used for cultivated crops, and 5 percent is used as woodland. The principal crops are corn and soybeans, but a limited acreage is used for wheat or grain sorghum. Flooding is a hazard throughout the association, and the wetness of the Colo and Zook soils is a management concern.

This association generally is unsuitable for sanitary facilities and building site development because of the flooding.

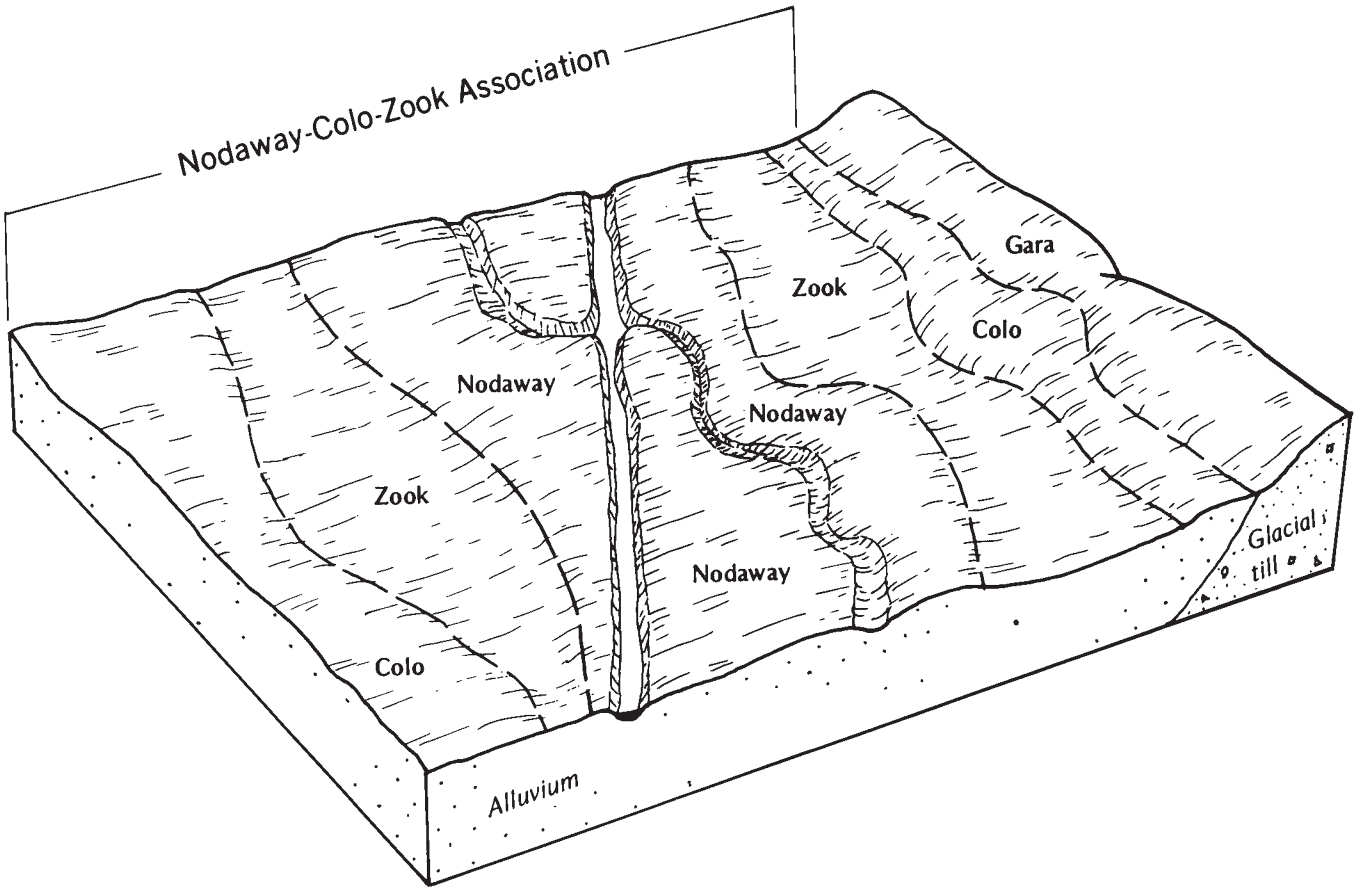


Figure 2.—Pattern of soils and parent material in the Nodaway-Colo-Zook association.

2. Leta-Haynie Association

Nearly level, somewhat poorly drained and well drained soils formed in alluvium; on flood plains along the Missouri River

This association is on the broad flood plains along the Missouri River. The landscape is characterized by very slight changes in elevation. The alluvium is dominantly loamy at the slightly higher elevations. Clayey alluvium covers the loamy material in the lower areas. A branching system of surface drainage ditches dissects the center of the bottom land. A federal levee system that parallels the river protects most of the bottom land, but flooding can occur if the levee breaks or tributary streams overflow.

This association makes up about 3 percent of the county. It is about 48 percent Leta soils, 38 percent Haynie soils, and 14 percent minor soils.

Leta soils are somewhat poorly drained and are in slight depressions. Typically, the surface layer is very dark grayish brown, friable silty clay about 8 inches thick. The subsurface layer also is very dark grayish brown, friable silty clay. It is about 3 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay about 16 inches thick. The substratum to a depth of 60 inches or more is stratified dark grayish brown and grayish brown, mottled, friable silt loam and very fine sandy loam.

Haynie soils are well drained and are in the slightly higher areas. Typically, the surface layer is dark brown, very friable very fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches is stratified brown and dark brown, very friable very fine sandy loam.

Minor in this association are the poorly drained Albaton soils on the lowest parts of the landscape and

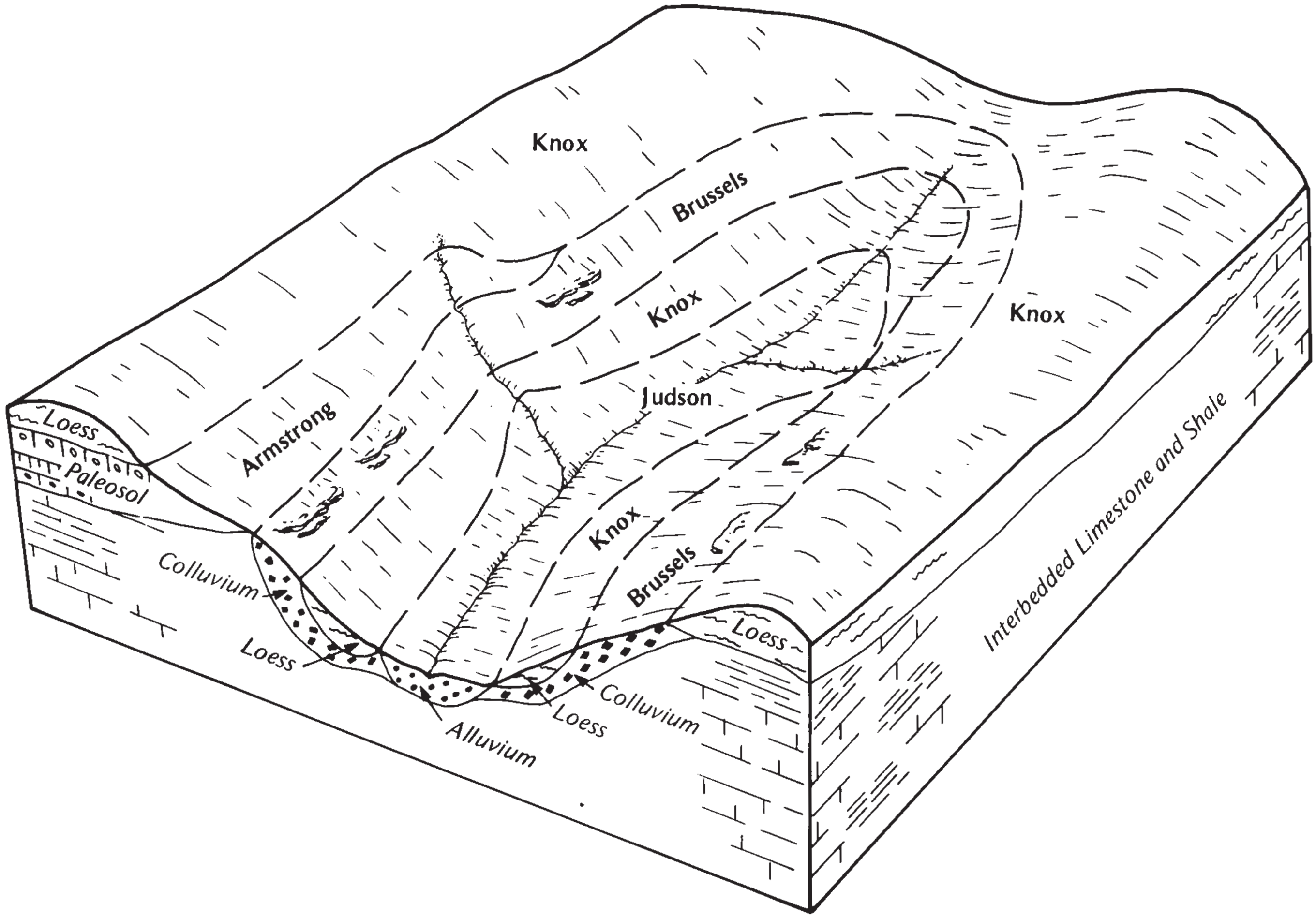


Figure 3.—Pattern of soils and parent material in the Knox-Brussels association.

the excessively drained Sarpy soils on the highest parts.

Most areas of this association are used for row crops. Nearly all of the protected areas are cultivated, except for isolated patches of brush or trees. Areas on the river side of the levee are occasionally flooded. They are used for cultivated crops, woodland, or wildlife habitat. The major soils are suited to corn, soybeans, and small grain and to grasses and legumes for pasture and hay. The wetness of the Leta soils is the main limitation.

A few buildings, mainly seasonal residences, are constructed in the protected areas. The major soils generally are unsuitable for sanitary facilities and building site development because of the hazard of flooding.

3. Knox-Brussels Association

Moderately sloping to very steep, well drained soils formed in loess and colluvium; on uplands

This association is on rugged, dissected hills characterized by strongly expressed local relief. Rolling to very steep side slopes are separated by long, winding, gently rolling ridgetops. Strips of woodland are common in areas along hillsides where limestone formations crop out. Numerous short drainageways are cut into the side slopes. The drainageways join and become creeks that flow in winding courses.

This association makes up about 19 percent of the county. It is about 55 percent Knox and similar soils, 17 percent Brussels soils, and 28 percent minor soils (fig. 3).

Knox soils are moderately sloping to steep. They are on ridgetops and side slopes. Typically, the surface layer is very dark grayish brown, friable silt loam or silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 35 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark yellowish brown and mottled. The substratum to a depth of 60 inches is dark yellowish brown, mottled, friable silt loam.

Brussels soils are moderately steep to very steep. They are on side slopes. They occur as strips parallel to hillsides. Fractured limestone and shale formations crop out on the hillsides. Typically, the surface layer is very dark grayish brown, firm very flaggy silty clay loam about 6 inches thick. The upper part of the subsoil is dark brown and dark yellowish brown, firm very flaggy silty clay loam. The lower part to a depth of 60 inches is dark yellowish brown, firm extremely flaggy silty clay loam.

Minor in this association are the somewhat poorly drained Armstrong and moderately well drained Gara and Rosendale soils on side slopes, the poorly drained Colo soils on small flood plains, the well drained Judson soils on foot slopes and in narrow drainageways, and the moderately well drained Nodaway soils on the larger flood plains.

About 75 percent of this association has been cleared. Most of the cleared areas are used for row crops, such as corn and soybeans. Some areas are used for pasture, and a few are used for commercial orchards. The moderately sloping soils and, to a limited extent, some of the strongly sloping soils are suitable for row crops. The moderately steep and steep soils are either too rocky or too erodible for cultivated crops. Water erosion is the principal hazard in all cultivated areas and in areas where pastures have been poorly managed.

The uncleared areas support native hardwoods. Oak, hickory, ash, sugar maple, and black walnut are the most common trees. Stand improvement is needed before the best timber production can be obtained. In the moderately steep to very steep areas, the equipment limitation, seedling mortality, and the hazards of erosion and windthrow are management concerns.

The Knox soils are generally suitable for sanitary facilities and building site development. The shrink-swell potential and the slope are the main limitations. The Brussels soils are generally unsuitable for these uses because of the slope and the large stones throughout the profile.

4. Marshall-Lamoni-Higginsville Association

Gently sloping to strongly sloping, well drained and somewhat poorly drained soils formed in glacial till and loess; on uplands

This association is on wide, interconnected ridgetops separated by long side slopes and narrow, branching drainageways. Scattered hedgerows and wooded draws segment crop fields.

This association makes up about 28 percent of the county. It is about 36 percent Marshall and similar soils, 32 percent Lamoni and similar soils, 21 percent Higginsville and similar soils, and 11 percent minor soils (fig. 4).

Marshall soils are gently sloping to strongly sloping and are well drained. They are on ridgetops and convex side slopes. Typically, the surface layer is very dark brown, friable silt loam or silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil to a depth of 60 inches or more is silty clay loam. The upper part is very dark grayish brown, brown, and dark yellowish brown and is firm; the next part is dark yellowish brown, mottled, and firm; and the lower part is dark yellowish brown, mottled, and friable.

Lamoni soils are moderately sloping and strongly sloping and are somewhat poorly drained. They are on side slopes and in concave areas. Typically, the surface layer is very dark grayish brown, friable silty clay loam or clay loam about 7 inches thick. The upper part of the subsoil is dark grayish brown, mottled, firm silty clay loam; the next part is dark grayish brown, brown, and yellowish brown, mottled, firm clay; and the lower part to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam.

Higginsville soils are moderately sloping and strongly sloping and are somewhat poorly drained. They are on side slopes and in concave areas on the upper part of drainageways. Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil to a depth of 60 inches or more is mottled, firm silty clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part.

Minor in this association are the poorly drained Colo soils on narrow flood plains and the well drained Shelby soils on side slopes at the lower elevations.

Most of the acreage in this association is used for crops, such as corn, soybeans, grain sorghum, and wheat. Some areas are used for pasture and hay. Some scattered areas, principally in draws and along fence rows, are wooded. Most areas of the association are suitable for cultivated crops. Because they are

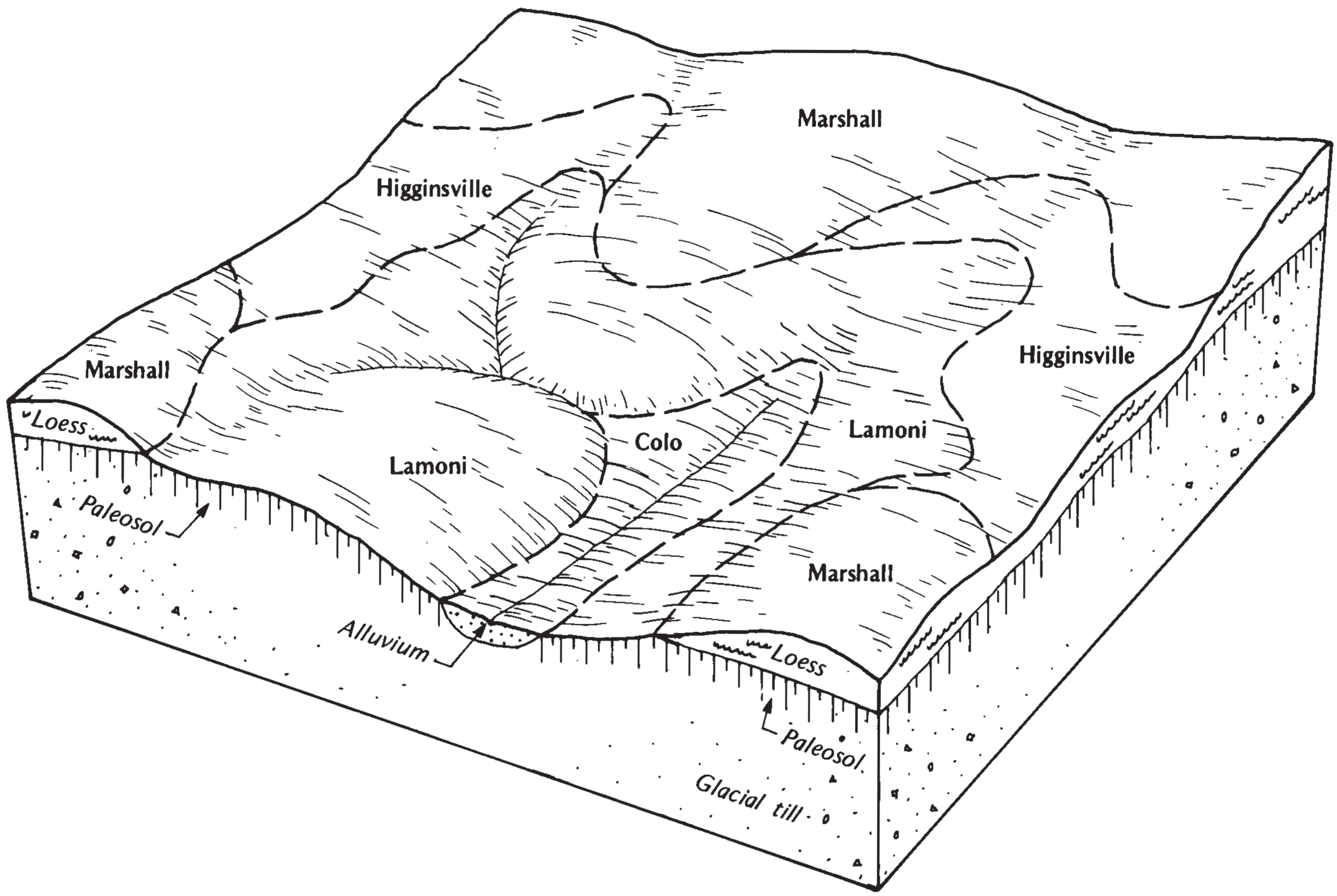


Figure 4.—Pattern of soils and parent material in the Marshall-Lamoni-Higginsville association.

extremely erodible, the strongly sloping areas are suitable only if the crops are grown on a limited basis. Water erosion is the major hazard in all cultivated areas and on poorly managed pastures. In areas of the Lamoni and Higginsville soils, surface wetness hinders fieldwork in spring and fall.

The major soils are suitable for sanitary facilities and building site development. The wetness of the Lamoni and Higginsville soils and the shrink-swell potential and slope of all three soils are the main limitations.

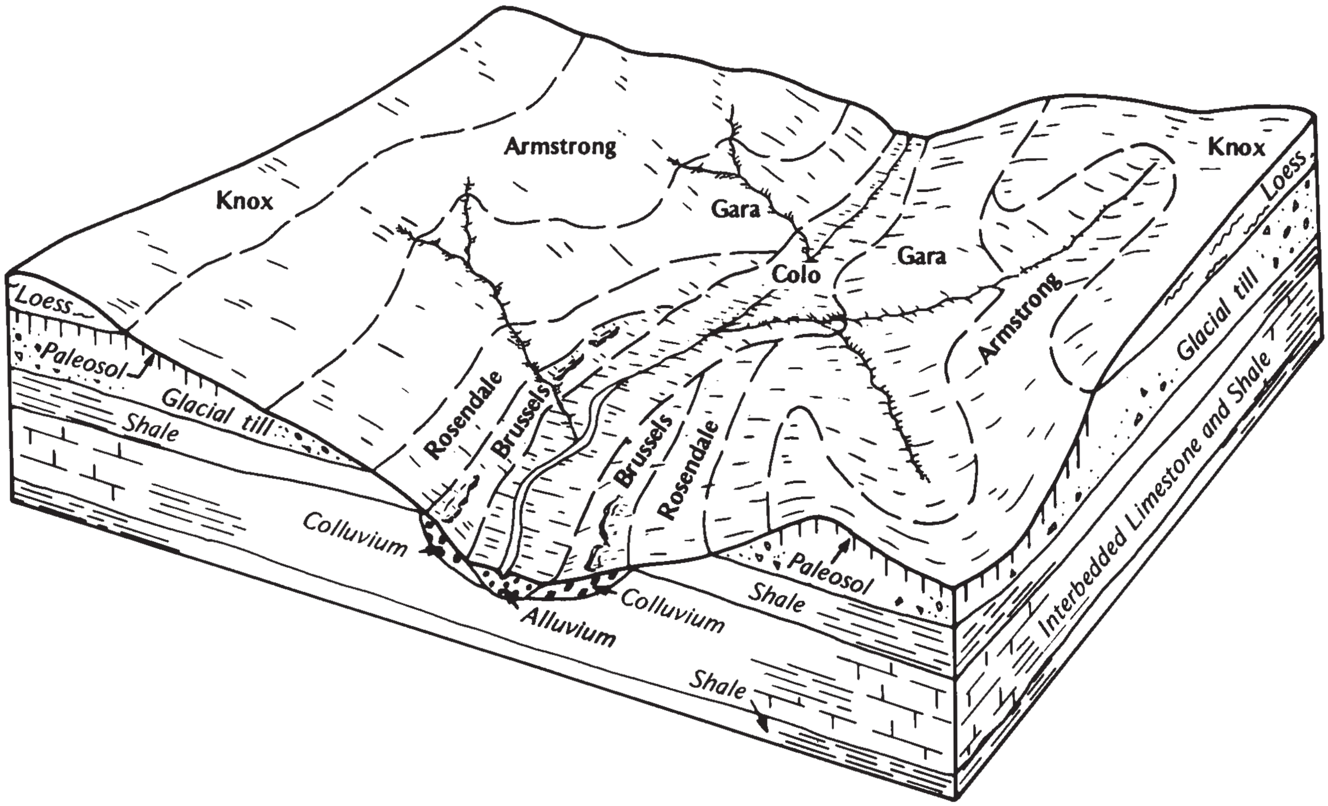
5. Knox-Gara-Armstrong Association

Moderately sloping to moderately steep, well drained to somewhat poorly drained soils formed in glacial till and loess; on uplands

This association is on long ridgetops that have numerous lateral side ridges. Sloping areas between the side ridges begin a branching drainage pattern that converges into narrow flood plains adjacent to medium-size rivers. Strongly sloping and moderately steep areas characterized by a prominent drainage pattern border the flood plains.

This association makes up about 19 percent of the county. It is about 23 percent Knox and similar soils, 21 percent Gara and similar soils, 20 percent Armstrong and similar soils, and 36 percent minor soils (fig. 5).

Knox soils are moderately sloping and strongly sloping and are well drained. They are on ridgetops and side slopes. Typically, the surface layer is very dark grayish brown, friable silt loam or silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 35 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark yellowish brown and mottled. The substratum to a depth



of 60 inches is dark yellowish brown, mottled, friable silt loam.

Gara soils are strongly sloping and moderately steep and are moderately well drained. They are on side slopes. Typically, the surface layer is very dark grayish brown, friable loam about 5 inches thick. The subsurface layer is dark brown, friable loam about 5 inches thick. The subsoil is firm clay loam about 40 inches thick. The upper part is dark brown, the next part is strong brown and yellowish brown, and the lower part is yellowish brown and mottled. The substratum to a depth of 70 inches is yellowish brown, mottled, firm clay loam.

Armstrong soils are moderately sloping and strongly sloping and are somewhat poorly drained. They are on secondary ridges and side slopes. Typically, the surface layer is very dark grayish brown, friable silt loam or clay loam about 7 inches thick. The subsoil is about 35 inches thick. It is mottled and firm. The upper part is dark brown silty clay loam, the next part is dark brown and yellowish brown clay, and the lower part is brown clay loam. The substratum to a depth of 60 inches is light brownish gray and yellowish brown, mottled, firm, calcareous clay loam.

Minor in this association are the well drained Brussels soils on the lower side slopes; the poorly drained Colo soils on narrow flood plains; the moderately well drained Nodaway soils on the wider flood plains; and the moderately well drained Rosendale soils on side slopes.

About 75 percent of this association has been cleared and is used for row crops, such as corn and soybeans, or for pasture and hay. Scattered wooded areas are throughout the association. This woodland is principally in draws and in areas that are too steep or too rocky for cultivated crops. The moderately sloping soils on ridgetops are suitable for row crops, and some areas of the strongly sloping soils on side slopes are suitable for row crops grown on a limited basis. The moderately steep areas are too erosive for cultivated crops. Water erosion is the major hazard in all cultivated areas and on poorly managed pastures. In

areas of the Armstrong soils, surface wetness hinders fieldwork in spring and fall.

The major soils are suitable for sanitary facilities and building site development. The wetness of the Armstrong soils and the shrink-swell potential and slope of all three soils are the main limitations.

6. Lamoni-Sharpsburg-Shelby Association

Gently sloping to strongly sloping, somewhat poorly drained to well drained soils formed in glacial till and loess; on uplands

This association is on long ridgetops that have numerous lateral side ridges. The side ridges are separated by long side slopes and narrow, branching drainageways.

This association makes up about 10 percent of the county. It is about 51 percent Lamoni and similar soils, 21 percent Sharpsburg and similar soils, 16 percent Shelby and similar soils, and 12 percent minor soils.

Lamoni soils are moderately sloping and strongly sloping and are somewhat poorly drained. They are on side slopes and in concave areas. Typically, the surface layer is very dark grayish brown, friable silty clay loam or clay loam about 7 inches thick. The upper part of the subsoil is dark grayish brown, mottled, firm silty clay loam; the next part is dark grayish brown, brown, and yellowish brown, mottled, firm clay; and the lower part to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam.

Sharpsburg soils are gently sloping and moderately sloping and are moderately well drained. They are on convex ridgetops and side slopes. Typically, the surface layer is very dark brown, friable silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 4 inches thick. The subsoil is firm silty clay loam about 32 inches thick. The upper part is very dark grayish brown and dark brown, the next part is dark yellowish brown and mottled, and the lower part is dark brown and grayish brown and is mottled. The substratum to a depth of 60 inches is grayish brown and dark brown, mottled, firm silty clay loam.

Shelby soils are strongly sloping and are well drained. They are on side slopes. Typically, the surface layer is very dark brown, friable loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown, friable clay loam about 7 inches thick. The subsoil is dark brown, dark yellowish brown, and yellowish brown, firm clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and dark yellowish brown, firm clay loam.

Minor in this association are the poorly drained Colo soils in small upland drainageways.

Most of this association is used for row crops, hay, or pasture. Dairy farms are common. The acreage of pasture and hay is higher in this association than in other parts of the county. Scattered wooded areas are throughout the association, principally in draws and along fence rows. Most areas in the association are suitable for cultivated crops. Because they are extremely erodible, the strongly sloping soils are suitable only if the crops are grown on a limited basis. Water erosion is the major hazard in all cultivated areas and on poorly managed pastures. In areas of the Lamoni soils, surface wetness hinders fieldwork in spring and fall.

In most areas this association is suitable for sanitary facilities and building site development. The wetness of the Lamoni soils and the shrink-swell potential and slope of all the major soils are the main limitations.

7. Arispe-Macksburg-Lamoni Association

Gently sloping and moderately sloping, somewhat poorly drained soils formed in loess and glacial till; on uplands

This association is on long, broad, branching ridges that have numerous lateral side ridges. Long, concave side slopes between the main ridges begin a branching drainage pattern that converges into narrow flood plains. A long, wide ridge known as the "Empire Prairie" is in the northeastern part of the county.

This association makes up about 10 percent of the county. It is about 40 percent Arispe soils, 28 percent Macksburg soils, 15 percent Lamoni soils, and 17 percent minor soils.

Arispe soils are moderately sloping and are on side slopes and in concave areas. Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is mottled, firm silty clay loam about 43 inches thick. The upper part is dark grayish brown, the next part is grayish brown, and the lower part is light brownish gray. A buried soil is below the subsoil. It is mottled, firm silty clay loam to a depth of 60 inches or more. It is very dark grayish brown in the upper part and light brownish gray in the lower part.

Macksburg soils are gently sloping and are on ridgetops. Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is firm silty clay loam about 10 inches thick. The upper part is black, and the lower part is very dark gray.

The upper part of the subsoil is dark grayish brown, firm silty clay loam; the next part is dark grayish brown, mottled, firm silty clay; and the lower part to a depth of 60 inches or more is grayish brown, mottled, firm silty clay loam.

Lamoni soils are moderately sloping and are on side slopes and in concave areas. Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The upper part of the subsoil is dark grayish brown, mottled, firm silty clay loam; the next part is dark grayish brown, brown, and yellowish brown, mottled, firm clay; and the lower part to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam.

Minor in this association are the poorly drained Colo soils on narrow flood plains and the moderately well drained Sharpsburg soils on secondary ridgetops.

Most of this association is used for crops, such as corn, soybeans, grain sorghum, and wheat. Some areas are used for pasture and hay. Most areas of the association are suitable for cultivated crops. Water erosion is the major hazard in all cultivated areas and on poorly managed pastures. Surface wetness hinders fieldwork in spring and fall.

The major soils are suitable for sanitary facilities and building site development. The wetness and the shrink-swell potential are the main limitations.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Knox silty clay loam, 9 to 14 percent slopes, eroded, is a phase of the Knox series.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps.

The descriptions, names, and delineations of the soils identified on the detailed soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

1B—Marshall silt loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on ridgetops in the uplands. Individual areas are long and narrow and range from 20 to several hundred acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil to a depth of 60 inches or more is silty clay loam. The upper part is very dark grayish brown, brown, and dark yellowish brown and is firm. The next part is dark yellowish brown, mottled, and firm. The lower part is dark yellowish brown, mottled, and friable. In some areas the dark surface soil is silty clay loam less than 10 inches thick. In places the soil is moderately sloping.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Most areas are too narrow to be managed separately, but they can be terraced and farmed on the contour along with the adjacent soils. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe. No woodland ordination symbol is assigned.

1C2—Marshall silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, well drained soil is on ridgetops and convex side slopes in the uplands. Individual areas are oblong or irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 42 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark yellowish brown and mottled. The substratum to a depth of 65 inches is dark yellowish brown, mottled, firm silty clay loam. In many small areas the dark surface soil is more than 10 inches thick and is silt loam. Some areas are gently sloping. In places the surface soil is dark brown.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Higginsville soils. These soils are in concave areas. They make up about 5 percent of the unit.

Permeability is moderate in the Marshall soil, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. Further erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

1D2—Marshall silty clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, well drained soil is on convex side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil is dark brown silty clay loam about 45 inches thick. The upper part is friable, the next part is firm, and the lower part is mottled and firm. The substratum to a depth of 68 inches is dark brown, firm silt loam. In some areas the very dark grayish brown surface layer is more than 10 inches thick and is silt loam. In other areas the surface soil is dark brown.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Higginsville soils. These soils are in concave areas. Also included are small areas of Shelby soils, which formed in glacial till on the lower slopes. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Marshall soil, and surface runoff is rapid. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suitable for row cropping only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Further erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It also is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Septic tank absorption fields should be installed across the slope.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential and slope are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

2C—Knox silt loam, 5 to 9 percent slopes. This deep, moderately sloping, well drained soil is on ridgetops and side slopes near intermediate streams in the uplands. Individual areas are oblong or irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsoil is firm silty clay loam about 35 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark yellowish brown and

mottled. The substratum to a depth of 60 inches is dark yellowish brown, mottled, friable silt loam. In places the surface layer is brown silty clay loam.

Permeability is moderate in the Knox soil, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Septic tank absorption fields generally function adequately in this soil.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. The woodland ordination symbol is 3A.

2D2—Knox silty clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, well drained soil is on side slopes near intermediate streams in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark brown, friable silty clay loam about 5 inches thick. The subsoil is dark brown and dark yellowish brown, firm silty clay loam about 39 inches thick. The substratum to a depth of 70 inches is dark yellowish brown, friable silt loam. In places the surface layer is silt loam. In severely eroded areas it is brown.

Included with this soil in mapping are small areas of the somewhat poorly drained Higginsville soils. These soils are in concave areas. They make up about 5 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops. This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Further erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water

erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Septic tank absorption fields should be installed across the slope.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential and slope are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling of the subsoil. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land.

The land capability classification is IIIe. The woodland ordination symbol is 3A.

2E2—Knox silty clay loam, 14 to 20 percent slopes, eroded. This deep, moderately steep, well drained soil is on side slopes near intermediate streams in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark brown, friable silty clay loam about 6 inches thick. The subsoil is firm silty clay loam about 40 inches thick. The upper part is dark yellowish brown and yellowish brown, the next part is yellowish brown and mottled, and the lower part is dark yellowish brown and mottled. The substratum to a depth of 72 inches is dark yellowish brown and yellowish brown, mottled, friable silt loam. In some severely eroded areas, the surface layer is brown. In places it is very dark grayish brown silt loam.

Included with this soil in mapping are scattered small areas of the flaggy Brussels and moderately well drained Rosendale and Gara soils. These soils make up about 10 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is low, and organic matter content is moderate. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops, pasture, hay, or woodland. Because of the slope, this soil can be used as cropland only on a very limited basis. Timely application of a system of minimum tillage that leaves a large amount of crop residue on the surface is necessary to prevent serious erosion damage.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

Some areas support native hardwoods. This soil is suited to trees. The erosion hazard, the equipment limitation, and seedling mortality are management concerns. Constructing logging roads and skid trails on the contour minimizes the gradient and length of slopes and the concentration of runoff. Seeding of disturbed areas may be necessary after harvesting is completed. In the steepest areas the logs should be yarded uphill to logging roads or skid trails. Planting container-grown nursery stock increases the seedling survival rate.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural lay of the land, but some grading generally is needed to modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Septic tank absorption fields should be installed across the slope.

On sites for local roads and streets, low strength, slope, and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. The roads can be designed so that they conform to the natural lay of the land. Also, some cutting and filling generally is necessary. Adequate roadside ditches and culverts help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is IVe. The woodland ordination symbol is 3R.

2F2—Knox silt loam, 20 to 35 percent slopes, eroded. This deep, steep, well drained soil is on side slopes near intermediate streams in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark brown, friable silt loam about 4 inches thick. The subsoil is about 50 inches thick. The upper part is dark yellowish brown, firm silty clay loam and silt loam; the next part is dark yellowish brown, mottled, firm silt loam; and the lower part is brown, mottled, friable silt loam. The substratum to a depth of 65 inches is grayish brown and brown, mottled, friable silt loam. In severely eroded areas the surface layer is brown silty clay loam.

Included with this soil in mapping are scattered small areas of the flaggy Brussels and moderately well drained Rosendale and Gara soils. These soils make up about 10 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is low, and organic matter content is moderate.

Most areas are used for row crops, pasture, hay, or woodland. This soil is too steep to be used as cropland and should be tilled only when pasture seeding is necessary. Timely application of a system of minimum tillage that leaves large amounts of crop residue on the surface is necessary to prevent serious erosion damage.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

Some areas support native hardwoods. This soil is suited to trees. The erosion hazard, the equipment limitation, and seedling mortality are management concerns. Constructing logging roads and skid trails on the contour minimizes the gradient and length of slopes and the concentration of runoff. Seeding of disturbed areas may be necessary after harvesting is completed. In the steepest areas the logs should be yarded uphill to logging roads or skid trails. Planting container-grown nursery stock increases the seedling survival rate.

This soil is suitable for building site development and onsite waste disposal. Buildings can be designed so that they conform to the natural lay of the land, but some grading generally is needed to modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Septic tank absorption fields should be installed across the slope.

Low strength, slope, and frost action are severe limitations on sites for local roads and streets. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. The roads can be designed so that they conform to the natural lay of the land. Also, some cutting and filling generally is necessary. Adequate roadside ditches and culverts help to prevent the damage caused by frost action.

The land capability classification is VIe. The woodland ordination symbol is 3R.

6C2—Arispe silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways in the uplands. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is mottled, firm silty clay loam about 43 inches thick. The upper part is dark grayish brown, the next part is grayish brown, and the lower part is light brownish gray. Below this to a depth of 60 inches or more is a buried soil. The buried soil is mottled, firm silty clay loam. It is very dark grayish brown in the upper part and light brownish gray in the lower part. In places the subsoil has glacial sand and pebbles. In many areas the dark surface layer is more than 10 inches thick. In some severely eroded areas, the surface layer is dark grayish brown silty clay loam. In some areas it is silt loam.

Permeability is moderately slow in the Arispe soil, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 2 to 4 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Further water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil

loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour (fig. 6). Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Properly designed sewage lagoons can function adequately, but the slope and the wetness are severe limitations. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength, frost action, and the high shrink-swell potential are severe limitations and the wetness is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action, shrinking and swelling, and wetness.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

7B—Sharpsburg silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on the convex tops of ridges in the uplands. Individual areas are long and narrow and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 4 inches thick. The subsoil is firm silty clay loam about 32 inches thick. The upper part is very dark grayish brown and dark brown, the next part is dark yellowish brown and mottled, and the lower part is dark brown and grayish brown. The substratum to a depth of 60 inches is grayish brown and dark brown, firm silty clay loam. In places the dark surface soil is less than 10 inches thick.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Macksburg soils. These soils are on broad ridgetops and in saddles. They make up about 5 percent of the unit.

Permeability is moderately slow in the Sharpsburg soil, and surface runoff is medium. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Most areas are too narrow to be managed separately, but they can be terraced and farmed on the contour along with the adjacent soils. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Because of the moderately slow

Figure 6.—Soybeans grown on the contour in an area of Arispe silty clay loam, 5 to 9 percent slopes, eroded.

permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged. Properly constructed sewage lagoons can function adequately, but seepage and slope are moderate limitations. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe. No woodland ordination symbol is assigned.

7C—Sharpsburg silt loam, 5 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on convex ridgetops and side slopes in the uplands. Individual areas range from 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsurface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsoil is firm silty clay loam about 35 inches thick. The upper part is dark brown, the next part is dark yellowish brown and mottled, and the lower part is dark yellowish brown and grayish brown and is mottled. The substratum to a depth of 60 inches is dark yellowish brown and grayish brown, mottled, firm silty clay loam. In places the dark surface soil is less than 10 inches thick.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Arispe soils. These soils are in concave areas. They make up about 5 percent of the unit.

Permeability is moderately slow in the Sharpsburg soil, and surface runoff is medium. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Because of the moderately slow permeability, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged. Properly constructed sewage lagoons can function adequately. The slope is a severe limitation, but it can be overcome by grading. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

8B—Macksburg silty clay loam, 2 to 5 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on the broad tops of ridges in the uplands. Individual areas are oblong and branching and commonly are several hundred acres or more in size.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is firm silty clay loam about 10 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil to a depth of 60 inches or more is firm silty clay loam. It is dark grayish brown in the upper part, dark grayish brown and mottled in the next part, and grayish brown and mottled in the lower part. In many places the dark surface soil is less than 16 inches thick. In some areas the subsoil is dominantly silty clay.

Permeability is moderately slow in the Macksburg soil, and surface runoff is medium. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 2 to 4 feet during extended wet periods.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass,

and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Properly designed sewage lagoons can function adequately, but the wetness is a severe limitation and the slope is a moderate limitation. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength, frost action, and the high shrink-swell potential are severe limitations and the wetness is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action, shrinking and swelling, and wetness.

The land capability classification is IIe. No woodland ordination symbol is assigned.

9C2—Higginsville silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways in the uplands. Individual areas commonly are crescent shaped and range from 5 to 300 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil to a depth of 60 inches or more is mottled, firm silty clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part. In places the dark surface soil is more than 10 inches thick. In some severely eroded areas, the surface layer is dark grayish brown.

Included with this soil in mapping are a few small areas of Lamoni soils on the lower parts of the landscape. These soils have glacial sand and pebbles in the subsoil. They make up about 5 percent of the unit.

Permeability is moderate in the Higginsville soil, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is moderate in the subsoil. A perched water table is at a depth of 1.5 to 3.0 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Further water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Properly constructed sewage lagoons can function adequately, but the slope and the wetness are severe limitations. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength and frost action are severe limitations and the wetness and shrink-swell potential are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

9D2—Higginsville silty clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways in the uplands. Individual areas commonly are crescent shaped and range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is mottled, firm silty clay loam about 37 inches thick. The upper part is brown and dark grayish brown, and the lower part is grayish brown. The substratum to a depth of 70 inches is grayish brown, mottled, firm silty clay loam. In places the dark surface soil is more than 10 inches thick. In some severely eroded areas, the surface layer is dark grayish brown.

Included with this soil in mapping are a few small areas of Lamoni soils on the lower parts of the landscape. These soils have glacial sand and pebbles in the subsoil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the Higginsville soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is moderate in the subsoil. A perched water table is at a depth of 1.5 to 3.0 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Further water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Properly constructed sewage lagoons can function adequately, but the slope and the wetness are severe limitations. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage. The sewage can be piped to adjacent areas that are better suited to lagoons or septic tank absorption fields.

On sites for local roads and streets, low strength and frost action are severe limitations and the wetness, the shrink-swell potential, and the slope are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

16B—Ladoga silt loam, 2 to 5 percent slopes. This deep, gently sloping, moderately well drained soil is on the tops of ridges near intermediate streams in the uplands. Individual areas are narrow and range from 10 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsoil to a depth of 60 inches or more is firm silty clay loam. The upper part is dark yellowish brown, the next part is dark yellowish brown and mottled, and the lower part is dark yellowish brown and grayish brown and is mottled. In places the very dark grayish brown surface layer is more than 10 inches thick.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Most areas are too narrow to be managed separately, but they can be terraced and farmed on the contour along with the adjacent soils. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suited to trees. Plant competition is the only management concern. It can be controlled by careful and thorough site preparation, which may include spraying or cutting.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Because of the moderately slow permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged. Properly constructed sewage lagoons can function adequately, but seepage and slope are moderate limitations. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength is a severe limitation and frost action and the shrink-swell potential are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe. The woodland ordination symbol is 4A.

16C2—Ladoga silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on ridgetops and side slopes near intermediate streams in the uplands. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is firm silty clay loam about 37 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is dark yellowish brown and mottled. The substratum to a depth of 60 inches is dark yellowish brown, mottled, firm silty clay loam. In a few places the very dark grayish brown surface layer is silt loam. In some severely eroded areas, the surface layer is dark brown.

Included with this soil in mapping are small areas of the somewhat poorly drained Armstrong and moderately well drained Gara soils on the lower parts of the landscape. These soils have glacial sand and pebbles throughout. They make up about 5 percent of the unit.

Permeability is moderately slow in the Ladoga soil, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Further water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding

other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

A few areas support native hardwoods. This soil is suited to trees. Plant competition is a management concern. It can be controlled by careful and thorough site preparation, which may include spraying or cutting.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Because of the moderately slow permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged. Properly constructed sewage lagoons can function adequately, but the slope is a severe limitation and seepage is a moderate limitation. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength is a severe limitation and frost action and the shrink-swell potential are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. The woodland ordination symbol is 4A.

23—Bremer silt loam. This deep, nearly level, poorly drained soil is on low stream terraces. It is subject to rare flooding. Individual areas are slightly elongated and range from 10 to 100 acres in size.

Typically, the surface layer is black, friable silt loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 15 inches thick. The subsoil to a depth of 60 inches or more is firm silty clay loam. The upper part is very dark gray, and the lower part is dark gray and mottled. Some narrow areas around the perimeter of the terraces are gently sloping. In places the soil is dark to a depth of less than 24 inches.

Included with this soil in mapping are several areas of somewhat poorly drained soils at the slightly higher elevations. Also included is an area where the surface layer is underlain by stratified, calcareous alluvium. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Bremer soil, and surface runoff is slow. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is high in the subsoil. A seasonal high water table is at a depth of 1 to 2 feet during extended wet periods.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. Hillside runoff and wetness are the main limitations. Diversions help to control the runoff. Surface drainage can be improved by land grading and surface ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and moderately suited to alsike clover, birdsfoot trefoil, ladino clover, bluegrass, and redtop. Hillside runoff and wetness are problems. Land grading and shallow ditches can help to remove excess water. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition (fig. 7).

This soil is suited to trees. The equipment limitation, plant competition, seedling mortality, and windthrow are management concerns. Equipment should be used only when the soil is dry or frozen. Plant competition can be controlled by careful and thorough site preparation, including spraying or cutting. Planting container-grown nursery stock and ridging the soil before planting increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil generally is unsuitable for building site development because of the rare flooding. The history of flooding in a given area should be considered when building sites are selected. Dwellings can be built on the adjacent uplands.

The land capability classification is IIw. The woodland ordination symbol is 7W.

26E—Rosendale silty clay loam, 9 to 30 percent slopes. This deep, strongly sloping to steep, moderately well drained soil is on side slopes near intermediate

Figure 7.—Dairy cattle grazing in a pastured area of Bremer silt loam.

streams and their tributaries in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark brown, friable silty clay loam about 8 inches thick. The subsoil is about 35 inches thick. It is firm. The upper part is dark brown and dark yellowish brown silty clay loam; the next part is dark brown and light olive brown, mottled silty clay loam; and the lower part is light yellowish brown, mottled silty clay. The substratum is light olive brown, mottled, firm shaly silty clay about 12 inches thick. Light olive brown, weathered shale bedrock is at a depth of about 55 inches. In some places the soil is noncalcareous throughout. In other places the surface layer has limestone fragments.

Included with this soil in mapping are a few areas of the well drained, flaggy Brussels soils. These soils are typically on the lower parts of the landscape. Also included are a few areas of the somewhat poorly drained Armstrong and well drained Knox soils, typically on the higher parts of the landscape. Included soils make up about 15 percent of the unit.

Permeability is slow in the Rosendale soil, and surface runoff is rapid. Available water capacity is

moderate. Natural fertility is low, and organic matter content is moderate. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 3 to 5 feet during extended wet periods.

Most areas are used for pasture (fig. 8), hay, or trees. Because of the hazard of water erosion, the low natural fertility, and the moderate available water capacity, this soil is generally unsuitable for row crops. It should be tilled only when pasture seeding is necessary.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suited to trees. The erosion hazard and the equipment limitation are management concerns. Constructing logging roads and skid trails on the contour minimizes the gradient and length of the slopes and the concentration of runoff. Seeding of disturbed areas may be necessary after harvesting is completed. In the steepest areas the logs should be yarded uphill to logging roads or skid trails.

This soil is suitable for building site development. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Onsite sewage disposal systems generally do not function adequately because of the slope and the slow permeability of the subsoil. Sewage can be piped to adjacent areas that are better suited to lagoons or septic tank absorption fields.

On sites for local roads and streets, low strength and slope are severe limitations and the shrink-swell potential and frost action are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. The roads can be designed so that they conform to the natural lay of the land. Also, some cutting and filling generally is necessary. Adequate roadside ditches and culverts help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is VIe. The woodland ordination symbol is 3R.

29F—Brussels very flaggy silty clay loam, 14 to 50 percent slopes. This deep, moderately steep to very steep, well drained soil is on side slopes near intermediate streams and their tributaries in the uplands. Individual areas are long and irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, firm very flaggy silty clay loam about 6 inches thick. The upper part of the subsoil is dark brown and dark yellowish, firm very flaggy silty clay loam. The lower part to a depth of 60 inches is dark yellowish brown, firm extremely flaggy silty clay loam. In many areas flagstones of limestone make up less than 35 percent of the volume in lower part of the subsoil.

Included with this soil in mapping are areas of bedrock outcrop. These areas typically are on the higher parts of the slopes. Also included are areas of the moderately well drained Rosendale soils, typically on the lower parts of the slopes. Included areas make up about 15 percent of the unit.

Permeability is moderately slow in the Brussels soil, and surface runoff is rapid. Available water capacity is low. Natural fertility also is low, and organic matter content is high. The shrink-swell potential is moderate in the subsoil.

Most areas are used as woodland. This soil is best suited to trees. The hazard of water erosion, the equipment limitation, and seedling mortality are management concerns. Constructing logging roads and skid trails on the contour minimizes the gradient and length of slopes and the concentration of runoff. Seeding of disturbed areas may be necessary after harvesting is completed. In the steepest areas the logs should be yarded uphill to logging roads or skid trails. Planting container-grown nursery stock increases the seedling survival rate. Because of the limestone fragments throughout the surface layer, hand planting or direct seeding may be necessary.

This soil generally is unsuitable as a site for dwellings, small commercial buildings, sanitary facilities, and local roads and streets because of the large stones and the slope. Alternative sites generally should be selected.

Figure 8.—A pastured area of Rosendale silty clay loam, 9 to 30 percent slopes.

The land capability classification is VIIs. The woodland ordination symbol is 3R.

33C—Armstrong silt loam, 5 to 9 percent slopes. This deep, moderately sloping, somewhat poorly drained soil is on secondary ridges and side slopes near intermediate streams and their tributaries in the uplands. Individual areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsoil is about 35 inches thick. It is mottled and firm. The upper part is dark brown silty clay loam, the next part is dark brown and yellowish brown clay, and the lower part is brown clay loam. The substratum to a depth of 60 inches is light brownish gray and yellowish brown, mottled, firm, calcareous clay loam. In many areas the surface layer is loam. In places the depth to calcareous clay loam is less than 42 inches.

Included with this soil in mapping are areas of the moderately well drained Gara soils at the lower ends of ridges and the moderately well drained Ladoga soils on the higher ridges. Included soils make up about 10 percent of the unit.

Permeability is slow in the Armstrong soil, and surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable,

but it can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. Some are used as woodland. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. If it is exposed when terraces are constructed, the clayey subsoil cannot be easily tilled. It is low in fertility and has a low available water capacity. As a result, topsoil may be needed. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

A few small areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown nursery stock increases the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Properly constructed sewage lagoons can function adequately, but the slope is a severe limitation. Grading can modify the slope.

On sites for local roads and streets, low strength, frost action, and the high shrink-swell potential are severe limitations and the wetness is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action, shrinking and swelling, and wetness.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

33D2—Armstrong clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, somewhat poorly drained soil is on side slopes near intermediate streams and their tributaries in the uplands. Individual areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 7 inches thick. The subsoil is mottled, firm clay about 42 inches thick. The upper part is dark brown, and the lower part is yellowish brown. The substratum to a depth of 60 inches is dark yellowish brown, mottled, firm clay loam. In some severely eroded areas, the surface layer is brown clay loam or clay. In places the depth to calcareous clay loam is less than 42 inches.

Included with this soil in mapping are areas of the moderately well drained Gara soils. These soils are in convex areas on the lower parts of the landscape. They make up about 10 percent of the map unit.

Permeability is slow in the Armstrong soil, and surface runoff is rapid. Available water capacity is moderate. Natural fertility and organic matter content are low. The surface layer is friable, but it can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Further water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. If it is exposed when terraces are constructed,

the clayey subsoil cannot be easily tilled. It is low in fertility and has a low available water capacity. As a result, topsoil may be needed. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

A few small areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown nursery stock increases the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Properly constructed sewage lagoons can function adequately, but the slope is a severe limitation. Grading can modify the slope. Also, the sewage can be piped to adjacent areas that are better suited to lagoons or septic tank absorption fields.

On sites for local roads and streets, low strength, frost action, and the high shrink-swell potential are severe limitations and the wetness and the slope are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action, shrinking and swelling, and wetness. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land.

The land capability classification is IVe. The woodland ordination symbol is 3C.

36C—Olmitz loam, 3 to 9 percent slopes. This deep, gently sloping and moderately sloping, moderately well drained soil is on foot slopes adjacent to flood plains along intermediate streams. Individual areas are long and irregular in shape and range from 10 to 160 acres in size.

Typically, the surface layer is very dark brown, friable loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown, friable clay loam about 14 inches thick. The subsoil is dark brown, friable clay loam about 28 inches thick. The substratum to a depth of 60 inches is dark yellowish brown, friable clay loam. In places the surface layer is silt loam.

Included with this soil in mapping are scattered small areas of the well drained Judson soils. These soils make up about 10 percent of the unit.

Permeability is moderate in the Olmitz soil, and surface runoff is medium. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Most areas receive runoff from the adjacent uplands. As a result, diversions may be needed. The area downslope from the diversion commonly is wide enough for terracing and farming on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to

orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. A diversion terrace generally is needed to keep runoff away from the buildings. Because of the moderate permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged. Properly constructed sewage lagoons can function adequately, but seepage and slope are moderate limitations. Grading can modify the slope. Sealing the bottom of the lagoon helps to prevent seepage.

On sites for local roads and streets, low strength is a severe limitation and frost action and the shrink-swell potential are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

37D—Gara loam, 9 to 14 percent slopes. This deep, strongly sloping, moderately well drained soil is on side slopes adjacent to intermediate streams and their tributaries in the uplands. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 5 inches thick. The subsurface layer is dark brown, very friable loam about 4 inches thick. The subsoil to a depth of 60 inches or more is firm clay loam. It is dark yellowish brown in the upper part, dark brown in the next part, and dark brown and mottled in the lower part. In places the depth to calcareous clay loam is less than 36 inches. In many eroded areas the surface layer is clay loam.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Armstrong soils. These soils are in concave areas on the higher parts of the landscape. They make up about 5 percent of the unit.

Permeability is moderately slow in the Gara soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops or for hay and pasture. This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Some areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

A few small areas support native hardwoods. This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Because of the slope and the moderately slow permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged and the distribution lines are installed across the slope. Properly constructed

sewage lagoons can function adequately, but the slope is a severe limitation. Grading can modify the slope. Also, the sewage can be piped to adjacent areas that are better suited to lagoons.

On sites for local roads and streets, low strength is a severe limitation and the slope, the shrink-swell potential, and frost action are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land. Adequate roadside ditches and culverts help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is IVe. The woodland ordination symbol is 3A.

37E—Gara loam, 14 to 20 percent slopes. This deep, moderately steep, moderately well drained soil is on side slopes adjacent to intermediate streams and their tributaries in the uplands. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 5 inches thick. The subsurface layer is dark brown, friable loam about 5 inches thick. The subsoil is firm clay loam about 40 inches thick. The upper part is dark brown, the next part is strong brown and yellowish brown, and the lower part is yellowish brown and mottled. The substratum to a depth of 70 inches is yellowish brown, mottled, firm clay loam. In many eroded areas the surface layer is clay loam. In places the depth to calcareous clay loam is less than 36 inches.

Included with this soil in mapping are a few small areas of Rosendale soils and the well drained, flaggy Brussels soils. Rosendale soils have less sand throughout than the Gara soil. Both of the included soils are on the lower parts of the landscape. They make up about 5 percent of the unit.

Permeability is moderately slow in the Gara soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is low, and organic matter content is moderate. The shrink-swell potential is moderate in the subsoil.

Most areas are used for pasture, hay, or woodland. This soil is too steep to be used as cropland. It should be tilled only when pasture seeding is necessary.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

A few areas support native hardwoods. This soil is suited to trees. The erosion hazard and the equipment limitation are management concerns. Constructing logging roads and skid trails on the contour minimizes the gradient and length of slopes and the concentration of runoff. Seeding of disturbed areas may be necessary after harvesting is completed. In the steepest areas the logs should be yarded uphill to logging roads or skid trails.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Because of the slope and the moderately slow permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged and the distribution lines are installed across the slope.

On sites for local roads and streets, low strength and the slope are severe limitations and the shrink-swell potential and frost action are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. The roads can be designed so that they conform to the natural lay of the land. Also, some cutting and filling generally is necessary. Adequate roadside ditches and culverts help to prevent the damage caused by shrinking and swelling and by frost action.

The land capability classification is VIe. The woodland ordination symbol is 3R.

42C2—Lamoni silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways in the uplands. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The upper part of the subsoil is dark grayish brown, mottled, firm silty clay loam. The next part is dark grayish brown, brown, and yellowish brown, mottled, firm clay. The lower part to a depth of 60 inches or more is yellowish brown, mottled, firm clay loam. In many areas the upper part of the subsoil is dark yellowish brown or strong brown and has red mottles. In some places the subsoil has no glacial sand or small pebbles. In other places the surface layer is very dark grayish brown and is more than 10 inches thick. In some severely eroded areas, it is dark grayish brown clay loam or clay. In places calcium carbonates are within a depth of 30 inches.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. This soil is suited to corn, soybeans, and small grain. Further erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting (fig. 9). Many areas are smooth enough and large enough to be terraced and farmed on the contour. If it is exposed when terraces are constructed, the clayey subsoil cannot be easily tilled. It is low in fertility and has a low available water capacity. As a result, topsoil may be needed. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Properly constructed sewage lagoons can function adequately, but the slope is a severe limitation. Grading can modify the slope.

On sites for local roads and streets, low strength and the high shrink-swell potential are severe limitations and the wetness and frost action are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by shrinking and swelling, wetness, and frost action.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

42D2—Lamoni clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, somewhat poorly drained soil is on side slopes and in concave areas near drainageways and tributaries of streams in the uplands. Individual areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 7 inches thick. The subsoil is about 34 inches thick. It is mottled and firm. The upper part is dark grayish brown clay loam, the next part is grayish brown clay, and the lower part is yellowish brown clay loam. The substratum to a depth of 60 inches is yellowish brown, mottled, firm clay loam. In many areas the upper part of the subsoil is dark yellowish brown or strong brown and has red mottles. In some severely eroded areas, the surface layer is dark grayish brown clay. In some places the very dark grayish brown surface layer is more than 10 inches thick. In other places calcium carbonates are within a depth of 30 inches.

Included with this soil in mapping are a few small areas of the well drained Shelby soils. These soils are in convex areas on the lower parts of the landscape. They make up about 5 percent of the unit.

Permeability is slow in the Lamoni soil, and surface runoff is rapid. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is high in the subsoil. A

Figure 9.—No-till soybeans emerging from wheat stubble in an area of Lamoni silty clay loam, 5 to 9 percent slopes, eroded.

perched water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for pasture and hay. Some are used for row crops. This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Further erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Some areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. If it is exposed when terraces are constructed, the clayey subsoil cannot be easily tilled. It is low in fertility and has a low available water capacity. As a result, topsoil may be needed. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to ladino clover and moderately well suited to big bluestem, indiangrass, alsike clover, birdsfoot

trefoil, crownvetch, lespedeza, bluegrass, and timothy. It is moderately suited to alfalfa, red clover, orchardgrass, and bromegrass. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Properly constructed sewage lagoons can function adequately, but the slope is a severe limitation. Grading can modify the slope. Also, the sewage can be piped to adjacent areas that are better suited to lagoons or septic tank absorption fields.

On sites for local roads and streets, low strength and the high shrink-swell potential are severe limitations and the wetness, the slope, and frost action are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by shrinking and swelling, wetness, and frost action. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land.

The land capability classification is IVe. No woodland ordination symbol is assigned.

44D—Shelby loam, 9 to 14 percent slopes. This deep, strongly sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 250 acres in size.

Typically, the surface layer is very dark brown, friable loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown, friable clay loam about 3 inches thick. The subsoil is dark brown, dark yellowish brown, and yellowish brown, firm clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and dark yellowish brown, firm clay loam. In many small areas the very dark brown surface soil is less than 10 inches thick. In places the depth to calcareous clay loam is less than 30 inches.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Lamoni soils. These soils are in concave areas on the higher parts of the landscape. They make up about 5 percent of the unit.

Permeability is moderately slow in the Shelby soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is high. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for hay and pasture. Some are used for row crops. This soil is suitable for row crops and small grain only if the crops are grown on a limited basis and intensive erosion-control measures are applied. Water erosion is a serious hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Terraces that have grassed back slopes or a narrow base may be more desirable than conventional terraces if row crops are grown. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to switchgrass and moderately well suited to other warm-season grasses, such as big bluestem and indiangrass. It is well suited to most cool-season grasses, such as timothy and bluegrass, and to most legumes, such as red clover and birdsfoot trefoil. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural lay of the land. Also, grading can

modify the slope. If the surface is exposed when the building site is leveled, special measures are needed to establish a plant cover and divert runoff away from the foundation. Because of the slope and the moderately slow permeability in the subsoil, septic tank absorption fields generally do not function adequately unless the absorption area is enlarged and the distribution lines are installed across the slope. Properly constructed sewage lagoons can function adequately, but the slope is a severe limitation. Grading can modify the slope. Also, the sewage can be piped to adjacent areas that are better suited to lagoons.

On sites for local roads and streets, low strength is a severe limitation and frost action, the slope, and the shrink-swell potential are moderate limitations. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Some cutting and filling may be necessary because of the slope. Also, the roads can be designed so that they conform to the natural lay of the land. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

53B—Judson silt loam, 2 to 7 percent slopes. This deep, gently sloping, well drained soil is on foot slopes and in upland drainageways. Individual areas commonly are long and irregular in shape and range from 10 to 160 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 7 inches thick. The subsurface layer is firm silty clay loam about 29 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil to a depth of 60 inches is dark brown, firm silty clay loam. In places the surface soil is less than 24 inches thick.

Included with this soil in mapping are some low areas of Judson soils that are subject to rare flooding of brief duration. Also included are the poorly drained Colo soils in some of the low areas. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Judson soil, and surface runoff is medium. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. Water erosion is a hazard if cultivated crops are grown. A combination of conservation practices helps to prevent excessive soil loss. No-till farming and other systems of conservation tillage leave a protective amount of crop residue on the surface after planting. Most areas receive extra runoff from the adjacent uplands. As a result, diversions may be necessary. The area downslope from the diversion may be wide enough for terracing and farming on the contour. Contour stripcropping alternates permanent strips of grasses or legumes with row crops, which are planted on the contour. The grass-legume strips minimize water erosion and help to control runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling water erosion. This soil is well suited to indiangrass, big bluestem, and other warm-season grasses and to alfalfa, red clover, and other deep-rooted legumes. It also is well suited to orchardgrass, timothy, bromegrass, and other cool-season grasses. Water erosion is a hazard in newly seeded areas. It can be controlled by contour tillage and by nurse crops or a protective cover of crop residue.

This soil is suitable for building site development and onsite waste disposal. Low areas directly adjacent to stream channels should not be developed for these uses because of the hazard of flooding. The basement walls, foundations, and footings of small commercial buildings and dwellings should be constructed with adequately reinforced concrete, which helps to prevent the structural damage caused by shrinking and swelling of the subsoil. A diversion terrace generally is needed to keep runoff away from the buildings. Septic tank systems generally function adequately in this soil.

On sites for local roads and streets, low strength and frost action are severe limitations and the shrink-swell potential is a moderate limitation. Crushed rock or other suitable base material helps to prevent the damage caused by low strength. Adequate roadside ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe. No woodland ordination symbol is assigned.

55A—Colo silty clay loam, 0 to 3 percent slopes. This deep, nearly level, poorly drained soil is in small upland drainageways and on flood plains along intermediate streams adjacent to the uplands. It is occasionally flooded. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay loam about 31 inches thick. The subsoil also is black, firm silty clay loam. It is about 11 inches thick. The substratum to a depth of 66 inches is very dark gray, mottled, firm silty clay loam. In places the surface soil is silty clay below a depth of 15 inches. Areas at the slightly higher elevations are subject to rare flooding.

Included with this soil in mapping are small areas of the well drained Judson and moderately well drained Olmitz soils on the higher foot slopes. Also included are some areas of the moderately well drained Nodaway soils on the wider parts of small flood plains. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Colo soil, and surface runoff is slow. Available water capacity is high. Natural fertility also is high, and organic matter content is very high. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is moderate. A seasonal high water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for row crops or for hay and pasture. A few narrow areas are wooded. This soil is suited to corn, soybeans, and small grain. Ditchbank erosion and runoff from the adjacent uplands are problems. Diversions help to protect the cropland against excessive runoff. Carefully maintaining a permanent plant cover along stream channels helps to stabilize ditchbanks. In some areas poor surface drainage can be improved by land grading and surface ditches. Because of the stream channels, some small upland drainageways are not accessible to farm equipment. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

The occasional flooding and the wetness are problems if this soil is used for hay or pasture. The best suited species are alsike clover and reed canarygrass. Land grading and shallow ditches can help to remove excess water. Grazing should be restricted to periods when flooding is not likely. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil generally is unsuitable for building site development because of the occasional flooding.

The land capability classification is IIw. No woodland ordination symbol is assigned.

56—Zook silty clay loam. This deep, nearly level, poorly drained soil is on flood plains along intermediate streams. It is occasionally flooded. Individual areas are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is about 28 inches thick. It is black, firm silty clay loam in the upper part and very dark gray, firm silty clay in the lower part. The subsoil to a depth of 60 inches is very dark gray and dark gray, mottled, firm silty clay. In some areas the soil is silty clay loam throughout. In other areas it is silty clay throughout. In places the surface layer is silt loam.

Permeability is slow, and surface runoff is very slow. Available water capacity is moderate. Natural fertility is medium, and organic matter content is very high. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is high. A seasonal high water table is within a depth of 3 feet during extended wet periods.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. The occasional flooding and the wetness are the main problems. Surface drainage can be improved by land grading and surface ditches. Diversions can protect areas adjacent to the uplands against excessive runoff. Deep tillage in the fall improves tilth and facilitates earlier seeding in the spring. If the soil is tilled when it is wet in the spring, the resulting seedbed is cloddy and cannot be easily managed. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and moderately suited to alsike clover, birdsfoot trefoil, ladino clover, bluegrass, and redtop. The occasional flooding and the wetness are problems in areas used for hay or pasture. Land grading and shallow ditches reduce the wetness. Grazing should be restricted to periods when flooding is not likely. Grazing when soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil generally is unsuitable for building site development because of the occasional flooding.

The land capability classification is IIw. No woodland ordination symbol is assigned.

58—Wabash silty clay. This deep, nearly level, very poorly drained soil is on flood plains along intermediate

streams. It is occasionally flooded. Individual areas are irregular in shape and range from 100 to 300 acres in size.

Typically, the surface soil is black, firm silty clay about 30 inches thick. The subsoil to a depth of 66 inches or more is very dark gray and dark gray, firm silty clay. In some areas the soil has a surface layer of silty clay loam and contains less clay throughout.

Permeability and runoff are very slow. Available water capacity is moderate. Natural fertility is low, and organic matter content is high. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is very high. A seasonal high water table is within a depth of 1 foot during extended wet periods.

Most areas are used for row crops. This soil is suited to corn, soybeans, and small grain. The occasional flooding and the wetness are serious problems. Surface drainage can be improved by land grading and surface ditches. Deep tillage in the fall improves tilth and facilitates earlier seeding in the spring. If the soil is tilled when it is wet in the spring, the resulting seedbed is cloddy and cannot be easily managed. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and moderately suited to alsike clover, birdsfoot trefoil, ladino clover, bluegrass, and redtop. The flooding and the wetness are problems in areas used for hay or pasture. Land grading and shallow ditches reduce the wetness. Grazing should be restricted to periods when flooding is not likely. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to trees. The equipment limitation, plant competition, seedling mortality, and windthrow are management concerns. Equipment should be used only when the soil is dry or frozen. Plant competition can be controlled by careful and thorough site preparation, including spraying or cutting. Planting container-grown nursery stock and ridging the soil before planting increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is generally unsuitable for building site development because of the occasional flooding.

The land capability classification is IIIw. The woodland ordination symbol is 4W.

61—Nodaway silt loam. This deep, nearly level, moderately well drained soil is on flood plains along intermediate streams. It is occasionally flooded. Individual areas are long and branching and typically are 1,000 acres or more in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 7 inches thick. The substratum to a depth of 60 inches is friable silt loam. The upper part is stratified very dark grayish brown, grayish brown, and dark grayish brown. The lower part is stratified dark grayish brown and grayish brown and is mottled. In places the upper part of the substratum is mottled. Some areas are frequently flooded. In several areas the substratum is not stratified.

Included with this soil in mapping are small areas of the poorly drained Colo soils. These soils are on foot slopes adjacent to the uplands. They make up about 5 percent of the unit.

Permeability is moderate in the Nodaway soil, and surface runoff is slow. Available water capacity is very high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate. A seasonal high water table is at a depth of 3 to 5 feet during extended wet periods.

Most areas are used for row crops. Some small, narrow areas are used as woodland or pasture. This soil is suited to corn, soybeans, and small grain. Measures that control floodwater are the only significant management needs. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is well suited to switchgrass and moderately well suited to big bluestem and other warm-season grasses. It is well suited to alfalfa, red clover, and most other legumes and to timothy, orchardgrass, and most other cool-season grasses. Grazing should be restricted to periods when flooding is not likely.

This soil is suited to trees. Plant competition is a management concern. It can be controlled by careful and thorough site preparation, which may include spraying or cutting.

This soil generally is unsuitable for building site development because of the occasional flooding.

The land capability classification is IIw. The woodland ordination symbol is 9A.

71—Albaton silty clay. This deep, nearly level, poorly drained soil is in the lowest areas on the flood plains along the Missouri River. It is protected by a

levee along the river but is subject to rare flooding. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay about 7 inches thick. The upper part of the substratum is stratified dark grayish brown, black, and very dark grayish brown, mottled, firm silty clay. The lower part to a depth of 60 inches is stratified olive gray, dark gray, and very dark gray, mottled, firm silty clay loam. Areas on the river side of the levee are occasionally flooded. Depressional areas that are not adequately drained are subject to ponding.

Included with this soil in mapping are small areas of the somewhat poorly drained Leta soils. These soils are in the higher areas. They make up about 10 percent of the unit.

Permeability is slow in the Albaton soil, and surface runoff is very slow or ponded. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is high. A seasonal high water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for row crops. This soil is suited to corn and soybeans. The wetness is a severe limitation. Surface drainage can be improved by land grading and surface ditches. If the soil is tilled when wet, the resulting seedbed is cloddy and cannot be easily managed. Deep tillage in the fall improves tilth and facilitates earlier seeding in the spring. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and moderately suited to alsike clover, birdsfoot trefoil, ladino clover, bluegrass, and redtop. The wetness is a problem in areas used for hay and pasture. It can be reduced by land grading and shallow ditches. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil generally is unsuitable for building site development because flooding can occur if tributary streams overflow or the levee along the Missouri River breaks.

The land capability classification is IIIw. No woodland ordination symbol is assigned.

72—Haynie very fine sandy loam. This deep, nearly level, well drained soil is in the higher areas on the flood plains along the Missouri River. It is protected by a levee along the river but is subject to rare flooding. Individual areas are irregular in shape and range from 5 to more than 1,000 acres in size.

Typically, the surface layer is dark brown, very friable very fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches is stratified brown and dark brown, very friable very fine sandy loam. In some places it is loamy very fine sand or silt loam. In other places the dark brown surface layer is more than 10 inches thick. In some small areas the soil has a surface layer of silty clay loam. Areas on the river side of the levee are occasionally flooded.

Included with this soil in mapping are small areas of the somewhat poorly drained Leta and excessively drained Sarpy soils. Leta soils have a surface layer of silty clay. They are in the lower areas. Sarpy soils have more sand throughout than the Haynie soil. They are in the slightly higher areas. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Haynie soil, and surface runoff is slow. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is low.

Most areas are used for row crops. This soil is suited to corn and soybeans. The only significant management needs are measures that control floodwater. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is well suited to switchgrass and moderately well suited to big bluestem and other warm-season grasses. It is well suited to alfalfa, red clover, and most other legumes and to timothy, orchardgrass, and most other cool-season grasses. No major problems affect pastured areas.

This soil is suited to trees. Plant competition is a management concern. It can be controlled by careful and thorough site preparation, including spraying or cutting.

This soil generally is unsuitable for building site development because flooding can occur if tributary streams overflow or the levee along the Missouri River breaks.

The land capability classification is I. The woodland ordination symbol is 11A.

76—Leta silty clay. This deep, nearly level, somewhat poorly drained soil is in the lower areas on the flood plains along the Missouri River. It is protected by a levee but is subject to rare flooding. Individual areas are irregular in shape and range from 5 to more than 1,000 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay about 8 inches thick. The subsurface layer also is very dark grayish brown, friable silty clay. It is about 3 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay about 16 inches thick. The substratum to a depth of 60 inches or more is stratified dark grayish brown and grayish brown, mottled, friable silt loam and very fine sandy loam. In some places the depth to loamy material is 12 to 20 inches. In other places the substratum is sandy. In some areas the surface layer is silty clay loam. Areas on the river side of the levee are occasionally flooded.

Included with this soil in mapping are small areas of the well drained Haynie soils. These soils have less clay in the surface layer and in the subsoil than the Leta soil. They are in the slightly higher areas. They make up about 5 percent of the unit.

Permeability is slow in the upper part of the Leta soil and moderate in the lower part. Surface runoff is slow. Available water capacity is high. Natural fertility is medium, and organic matter content is high. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is high in the upper part of the soil and low in the lower part. A seasonal high water table is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for row crops. This soil is suited to corn and soybeans. The wetness is the chief limitation. Surface drainage can be improved by land grading and surface ditches. If the soil is tilled when wet, the resulting seedbed is cloddy and cannot be easily managed. Deep tillage in the fall improves tilth and facilitates earlier seeding in the spring. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and moderately suited to alsike clover, birdsfoot trefoil, ladino clover, bluegrass, and redtop. The wetness is a problem in areas used for hay or pasture. It can be reduced by land grading and shallow ditches.

This soil is suited to trees. The equipment limitation, seedling mortality, and windthrow are management concerns. Equipment should be used only when the soil is dry or frozen. Planting container-grown nursery stock and ridging the soil before planting increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil generally is unsuitable for building site development because flooding can occur if tributary streams overflow or the levee along the Missouri River breaks.

The land capability classification is IIw. The woodland ordination symbol is 7C.

80—Sarpy loamy fine sand. This deep, nearly level, excessively drained soil is on low ridges on the flood plains along the Missouri River. It is protected by a levee but is subject to rare flooding. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is dark brown, very friable loamy fine sand about 7 inches thick. The substratum to a depth of 60 inches is stratified dark grayish brown, light brownish gray, and grayish brown loamy fine sand and fine sand. Areas on the river side of the levee are occasionally flooded.

Permeability is rapid, and surface runoff is slow. Natural fertility, available water capacity, organic matter content, and the shrink-swell potential are low.

Most areas are used for row crops or pasture. Because of droughtiness, this soil is poorly suited to row crops. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the available water capacity. Irrigation can increase productivity in row cropped areas.

This soil is moderately well suited to big bluestem, switchgrass, and other warm-season grasses and to crownvetch, lespedeza, orchardgrass, and reed canarygrass. It is moderately suited to other legumes and cool-season grasses. Overgrazing during dry summer months reduces forage production and increases the extent of weeds. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is suited to trees. Seedling mortality is a management concern. Planting container-grown nursery stock increases the seedling survival rate.

This soil generally is unsuitable for building site development because flooding can occur if tributary streams overflow or the levee along the Missouri River breaks.

The land capability classification is IVs. The woodland ordination symbol is 8S.

99—Pits, quarries. This map unit consists of open excavations from which soil material has been removed and the underlying limestone mined.

A typical pit has a vertical exposure on two or three sides. These exposures are 10 to more than 50 feet high. They are made up of the limestone being quarried and the overlying formations, mainly of shale but also of limestone. The unconsolidated overburden occurs as layers of glacial material 3 to 10 feet thick. In most areas 3 to 10 feet of loess overlies the glacial material. The overburden is removed and stockpiled in the undisturbed adjacent areas or placed in previously mined pits.

About 40 percent of this unit consists of rubble and spoil piles. About 30 percent consists of packed roadways and stockpiles of gravel and lime. The remaining 30 percent is the active pit area. Areas of rubble and spoil are rough and steep. Some are sparsely covered with weeds, brush, and rapidly growing softwoods. In some areas drainage outlets are not available, and the pits are filled with water. Most inactive quarries can be reclaimed and used as wildlife habitat or recreational areas. Some fringe areas can be used as sites for dwellings.

No land capability classification or woodland ordination symbol is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 5 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 87,170 acres in Andrew County, or more than 31 percent of the total acreage, is prime farmland. Most of the prime farmland is in the eastern part of the county. Approximately 60,150 acres of this land is used for crops, mainly corn, soybeans, winter wheat, grain sorghum, and hay *(14)*.

A recent trend in land use in some parts of the county has been the conversion of small acreages of prime farmland to urban development. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

If a soil meets the requirements for prime farmland only in areas where it is drained, the words "where drained" are added in parentheses after the map unit name in table 5. Onsite investigation is needed to determine whether or not a specific area of the soil is adequately drained. The naturally wet soils in Andrew County generally have been adequately drained through the application of drainage measures or the incidental drainage that results from farming or other kinds of land development.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis for making predictions about soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate probable sources of sand and gravel, roadfill, and topsoil. They can use the survey to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and other specialists may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Ted E. Utz, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1982, approximately 226,200 acres in Andrew County, or about 81 percent of the total area, was used for crops and pasture *(14)*. Of this total, about 145,000 acres was used as cropland; 67,100 acres as permanent pasture; and 14,100 acres as hayland.

The most commonly grown grain crops are corn, soybeans, grain sorghum, and wheat. In 1982, soybeans were grown on about 78,700 acres, corn on 40,000 acres, wheat on 23,800 acres, and grain sorghum on 2,500 acres. Oats and rye can be grown, and grass seed could be produced from indiangrass, switchgrass, big bluestem, bromegrass, orchardgrass, and other species.

The paragraphs that follow describe the main management needs on the cropland, hayland, and pasture in the county. These needs are measures that control water erosion, reduce wetness, control floodwater, and help to maintain fertility and tilth.

Water erosion is the major problem on nearly all of the sloping cropland and overgrazed pasture in Andrew County. All soils that have slopes of more than 2 percent are susceptible to erosion.

Only about 33 percent of the cropland and hayland in Andrew County is adequately treated for conservation needs. The inadequately treated cropland occurs mainly as soils on uplands that are being farmed in a manner that causes erosion in excess of what is considered tolerable for the production of crops over a long period. Some of the marginal cropland used for row crops should be converted to pasture and hayland. Erosion on most of the cropland can be held within tolerable limits, generally 2 to 5 tons per acre per year, by conservation practices designed for specific sites. Many fields in which no conservation measures are applied lose more than 30 tons per acre per year.

Loss of the surface layer through erosion is damaging for three reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Under these conditions, a good seedbed cannot be easily prepared and achieving good germination rates becomes increasingly difficult. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Armstrong and Lamoni soils. Erosion also reduces the available water capacity of the soil, resulting in severe yield reductions during periods of drought.

Second, valuable slow-release nutrients in the topsoil are removed through erosion. In 1985, the nutrients in 1 ton of topsoil were worth about 5 or 6 dollars. At that rate, unprotected fields in the uplands commonly lose 100 to 200 dollars worth of nutrients each year.

Third, erosion on farmland results in the sedimentation of streams, lakes, ponds, and road ditches. Control of erosion minimizes the pollution of streams and improves the quality of water for municipal use, for recreation, and for fish and wildlife. Such control also prolongs the useful life of ponds, lakes, drainage canals, and roadside ditches.

Erosion-control measures protect the surface, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a protective amount of vegetation or crop residue on the surface can hold soil losses to amounts that will not reduce the productive capacity of the soils. Including small grain in the cropping sequence and growing grasses and legumes for pasture and hay are very effective in controlling erosion. When included in crop rotations, legumes, such as clover and alfalfa, also improve tilth and provide nitrogen for the following crop.

Basic management techniques can significantly reduce soil loss. Farming on the contour, for example, reduces soil loss by as much as 50 percent. Conservation tillage reduces the number of tillage operations on a field and increases the amount of crop residue left on the surface. The residue protects the soil against the impact of raindrops, which dislodge unprotected topsoil. The effectiveness of the residue depends on the percentage of the surface that is covered. Conservation tillage is well suited to all of the upland soils commonly used for row crops.

No-till farming is an example of conservation tillage. It eliminates tillage operations entirely and leaves nearly all of the crop residue on the surface. Increasing numbers of farmers in the county are finding this to be a cornerstone of their conservation efforts. Other benefits of no-till farming include less expenditure for equipment and fuel, less soil compaction, time savings during the planting season, and conservation of soil moisture.

The large amounts of crop residue left on the surface under a system of no-till farming shield the soil from sunshine and thus slow the rate of evaporation. This slower rate is an asset during droughty periods in the summer, but it tends to delay warming and drying of the soil in the spring. For this reason, no-till farming is most effective on moderately well drained or well drained soils, including Gara, Haynie, Judson, Knox, Ladoga, Marshall, Nodaway, Olmitz, Sharpsburg, and Shelby soils.

Contour stripcropping helps to control erosion and runoff. In areas where this measure is applied, a permanent cover of grasses or legumes is maintained in contoured strips. The grasses or legumes generally are used for hay. The areas between the strips are cultivated. Row crops are planted on the contour in these areas.

Terraces reduce the length of slopes and thus the risks of runoff and erosion. Conventional terraces are most practical on uneroded upland soils that have long, smooth slopes of less than 8 percent. Special construction and management techniques are necessary if terrace systems are to be effective in most of the strongly sloping areas of Armstrong, Gara, Higginsville, Knox, Lamoni, Marshall, and Shelby soils. If the terraces have grassed back slopes or a narrow base, the gradient of the slopes is reduced because construction cuts are made from the downslope side (fig. 10). Construction of conventional terraces increases the gradient. As a result, additional erosion-control measures are crucial. On Armstrong and Lamoni soils, special management techniques may be required in areas where terracing exposes the clayey subsoil.

Grade-stabilization structures, which generally impound small bodies of water, protect gullied areas and prevent further uphill gullying. Tile terrace outlets or

Figure 10.—A terrace that has a grassed back slope in an area of the Knox-Brussels association.

grassed waterways can safely empty runoff from terraced fields into these structures.

All of the eroded upland soils have a higher content of clay in the surface layer than the corresponding uneroded soils. Because of the higher content of clay, tilth is poorer, the rate of water infiltration is slower, and the runoff rate is more rapid. Measures that prevent further erosion are needed on these soils. Fall plowing of upland soils still occurs in the county, but it is a poor practice on most of these soils because it greatly accelerates erosion.

Wetness and *flooding* are management concerns on about 19 percent of the acreage used for crops and pasture in the county. Albaton, Bremer, Colo, Leta, Wabash, and Zook soils are naturally so wet that planting is delayed or crop production is reduced during some part of most years. Some land grading or a surface drainage system may be needed on these soils. Occasional flooding can be a problem on Colo, Nodaway, Wabash, and Zook soils. The flooding commonly occurs during the period February through November. Albaton, Bremer, Haynie, Leta, and Sarpy soils are subject to rare flooding.

Soil fertility is naturally lower in most eroded soils than in uneroded soils. On all soils, however, additional plant nutrients are needed. Most of the soils are naturally acid in the upper part of the root zone. Applications of ground limestone are needed to raise the pH and calcium levels sufficiently for the optimum growth of legumes. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and on the desired level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to be applied. Soil sampling can be planned on the basis of the contrasting soil types identified in this survey.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. The tilth of each soil is described under the heading "Detailed Soil Map Units."

Most of the uneroded upland soils used for crops have a surface layer of silt loam or silty clay loam that is dark and is moderate or high in content of organic matter. Generally, the structure of the silt loams becomes weaker if the soils are tilled and compacted. A surface crust forms during periods of heavy rainfall. Because it is hard when dry, the crust reduces the rate of water infiltration and increases the runoff rate. Regular additions of crop residue, manure, and other organic material improve soil structure and tilth.

Tilth is a problem in Albaton, Leta, Wabash, and Zook soils, which often stay wet until late in the spring. If they are tilled when wet, these soils tend to be cloddy when dry. As a result, preparing a seedbed is difficult. Plowing these soils in the fall generally results in better tilth. It does not result in excessive erosion because the soils are nearly level.

In the areas of *pasture and hayland* in Andrew County, a combination of different grasses and legumes is necessary if maximum forage production is to be obtained. Cool temperatures in the spring and fall favor the production of cool-season grasses. The hot summer months favor the production of warm-season grasses. Most of the soils in the county are suited to both kinds of grasses. Some are suitable for legumes. A management system that includes cool-season grasses, warm-season grasses, and legumes takes advantage of the entire growing season.

The most commonly grown cool-season grasses in the county are tall fescue, smooth bromegrass, orchardgrass, Kentucky bluegrass, timothy, and reed canarygrass. All of these grasses commonly are grown on upland soils, except for reed canarygrass, which is planted primarily on the wetter bottom land. Optimum production of cool-season grasses can be achieved only if good management is applied. Rotation grazing helps to keep the grasses at an optimum height. Applications of fertilizer and timely weed control also are essential.

Cool-season grasses grow vigorously when temperatures are between 50 and 85 degrees F. These grasses generally start growing in late March and can be grazed by late April. Timothy and smooth bromegrasses cannot produce tillers unless a seedhead is allowed to develop. Therefore, overgrazing or haying too early in the growing season reduces the total production of forage. Orchardgrass regrows vigorously with or without the development of a seedhead. As a result, the timeliness of grazing or haying is less critical. Bluegrass generally is less productive than the other cool-season grasses, but it can better withstand overgrazing and poor management. Tall fescue also can withstand abuse, but fescue foot, poor palatability, and endophyte fungus can be problems. Reed canarygrass is moderately palatable and is highly productive in areas that are too wet for other grasses or for row crops.

Because of increasing temperatures and longer days, the production of cool-season grasses decreases significantly by mid-June. Growth is again stimulated by cooler fall temperatures and shorter days. Production continues until the first severe frost occurs, usually in late October. One exception to this growth pattern is tall fescue, which continues to grow until sometime in December.

Warm-season grasses that are commonly grown in Andrew County include big bluestem, indiangrass, switchgrass, and little bluestem. These grasses are native to the county and were abundant before settlement by the pioneers. Originally, they covered about half of the county. They were the dominant plants because they are adapted to the soils and climate of the county, as is vividly demonstrated during the hot summer months of June, July, and August. These grasses reach their peak production when the temperature reaches 90 degrees F. Growth slows when the temperatures fall below 70 degrees F. Warm-season grasses require only 40 percent as much water as cool-season grasses. This advantage can significantly affect the production of forage during the summer.

Strict management techniques are necessary for the optimum production and longevity of warm-season grasses. Rotation grazing allows the grasses to be grazed during periods when they are growing vigorously and prevents overgrazing during dormant periods.

Guidelines for minimum grazing heights should be followed. The amount of supplemental fertilizer needed in areas of these grasses is small compared to the amount needed in areas of cool-season grasses. Generally, nitrogen is the only supplement needed for optimum production.

Legumes are grown in many of the areas used for forage in Andrew County. They improve overall forage quality and increase the quantity. If included with grasses in a seeding mixture, they stimulate growth of the grasses because bacteria fix nitrogen on the roots of the legumes.

Pure stands of legumes are sources of high-protein forage. Some legumes, such as alfalfa and ladino clover, can cause bloating in livestock if unrestricted grazing is allowed; therefore, most pure stands are used for hay. Alfalfa is the most common legume grown for hay. Other legumes, such as red clover, birdsfoot trefoil, and ladino clover, are used in pasture mixtures. Crownvetch is used to stabilize steep banks and critically eroding areas.

Good management of the areas where legumes are grown includes the selection of soils that are compatible with the growth characteristics of the various plants. Most legumes require well drained or moderately well drained soils, such as Knox, Marshall, Olmitz, Judson, Sharpsburg, Ladoga, Gara, and Shelby soils. Some legumes, such as alsike clover, can grow in the wetter soils.

Legumes do not require additions of nitrogen because of the natural fixation that occurs in the root system. If the legumes are used for hay, large amounts of phosphorus and potassium commonly are needed. Heavy applications of limestone also are needed for optimum production on most soils.

Specialty crops, such as apples, peaches, tobacco, sunflowers, watermelons, and Christmas trees, are grown on a limited basis in Andrew County (fig. 11). These crops require special equipment, management, and propagation techniques. This soil survey can help to identify areas of soils that are suitable for such crops.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations on sites for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland or for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(12)*. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and

Figure 11.—An orchard in an area primarily of Marshall soils.

narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations or hazards that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations or hazards that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations or hazards that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

There are no class V or class VIII soils in Andrew County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w,* or *s,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); and *s* shows that the soil is limited mainly because it is shallow, droughty, or stony. In class I there are no subclasses because the soils of this class have few limitations.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

James L. Robison, forester, Soil Conservation Service, helped prepare this section.

Approximately 15 percent of Andrew County is forested. Upland forests are primarily in the Knox-Brussels and Knox-Gara-Armstrong soil associations, which are described under the heading "General Soil Map Units." Common oak species include white oak, northern red oak, chinkapin oak, bur oak, and black oak. Other common species are shagbark hickory, bitternut hickory, basswood, black walnut, white ash, and elm. The timber stands typically are in the steeper areas of these associations. In other areas the woodland has been cleared and converted to cropland, hayland, or pasture.

Bottom-land species grow in areas of the Nodaway-Colo-Zook and Leta-Haynie associations. The woodland in these associations generally is in wet areas or in unprotected areas that cannot be used as cropland because of the frequency of flooding. Cottonwood, silver maple, ash, and boxelder are the dominant timber species on most of the flood plains.

An understanding of soils helps to explain how forest types develop and tree growth occurs. The soil serves as a reservoir for moisture, provides an anchor for roots, and supplies most of the available plant nutrients. Soil properties that directly or indirectly affect these growth requirements include reaction, fertility, drainage, texture, structure, and depth. Landscape position also is important. Although little can be done to change the limitations of the soils, proper management of the species best suited to the soils helps to maximize woodland productivity.

The supply of plant nutrients in the soil affects tree growth. Decomposition of the leaf litter that has accumulated in the forest ecosystem over long periods recycles the nutrients. Fire, excessive trampling by livestock, and erosion can result in a loss of these nutrients and in reduced productivity on the site. Forest management should include fire prevention and protection from overgrazing.

Among the site characteristics that affect tree growth are aspect and position on the landscape. These characteristics influence such factors as the amount of available sunlight, aeration, soil temperature, and moisture relations.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the

slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and

screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service, the Missouri Department of Conservation, or the Cooperative Extension Service or from a commercial nursery.

Recreation

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

In 1980, Andrew County had 4,078 acres of recreational developments *(9)*. About 70 percent of this acreage was state owned. The rest was divided among municipal, school, and other local entities. The facilities included swimming areas, hunting and fishing areas, campgrounds, trails, game courts, ballfields, picnic areas, play areas, horse arenas, and wildlife-viewing areas. A 1976 report projected a need to increase the miles of foot trails and bike paths and the acres of playfields, picnicking and camping areas, fishing waters, and hunting areas by the target year of 1990. The population of the county was projected to increase to 16,300 by that year *(5)*.

The Honey Creek Wildlife Area, which is more than 1,400 acres in size, is the largest public recreational area in the county. This state-owned area offers opportunities for fishing, hunting, and wildlife viewing. Three state-owned wildlife areas are the only other public recreational areas larger than 100 acres. Several smaller areas, including access areas for fishing and small parks, are available to the general public.

A 1974 inventory identified eight private and semiprivate commercial recreation enterprises in the county *(7)*. These enterprises included a scout camp, golf courses, a race track, campgrounds, and pay fishing lakes.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm

when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

Andrew County is among the 12 counties in Missouri that make up the Northwest Prairie Zoogeographic Region. Prior to cultivation, about 65 percent of this region was prairie and 35 percent was woodland *(6)*. Currently, none of the original prairie remains. The most important problem affecting wildlife habitat is the loss of woodland through land use conversion. Conversion to cropland has resulted in the loss of wooded draws and larger wooded areas and of fence rows and hedgerows.

The game species in Andrew County are primarily those that prefer an openland habitat in an agricultural area. Soybeans, corn, and wheat are the chief grain crops grown in the county. The Nodaway-Colo-Zook, Leta-Haynie, Marshall-Lamoni-Higginsville, Lamoni-Sharpsburg-Shelby, and Arispe-Macksburg-Lamoni soil associations, which are described under the heading "General Soil Map Units," provide most of the openland habitat in the county. The associations that are dominantly woodland also have large acreages of cropland and grassland.

Bobwhite quail is one of the most popular game species in the county. The quail and rabbit populations are fair. They are increased by an abundant supply of food in close proximity to sufficient woody cover. The dove population is good and increases seasonally during migratory flight periods. The population of pheasants is fair. It is increasing as this species expands its range into suitable habitat.

In 1972, about 16,100 acres in the county was classified as commercial forest land *(3)*. The county currently has about 60,000 acres of wooded habitat, including areas of brush and noncommercial forest land. The Knox-Brussels and Knox-Gara-Armstrong associations are dominantly wooded. The timbered parts of the other associations also provide habitat for woodland wildlife.

The deer population is good and is steadily increasing. Deer are heavily hunted by local sportsmen and residents of the St. Joseph area. Because of the limited amount of woodland habitat remaining in the county, turkeys are scarce. The squirrel population is good. This game animal is not heavily hunted. The county has a small resident population of woodcock. An experimental stocking of ruffed grouse has been made in the Honey Creek Wildlife Area.

The furbearer population is excellent. The number of trappers has stabilized after a decline in fur values. Raccoon, muskrat, coyote, opossum, beaver, skunk, and mink are the principal species trapped. Coyotes are increasingly hunted by organized groups.

Nearly all of the wetland remaining in the county is in the Nodaway-Colo-Zook and Leta-Haynie associations, which are on flood plains. The overall waterfowl population is fair. The county has no large areas where waterfowl concentrate during migratory flight periods in the fall. A good population of wood ducks is on ponds and on a few streams that meet the strict habitat requirements of these birds. Periodically, waterfowl from the Squaw Creek National Wildlife Refuge in Holt County feed on crop fields in Andrew County. Some of the lakes and ponds in Andrew County are used as resting sites during migratory flight periods in the spring and fall. The birds commonly are hunted on the bottom land along the Missouri and Nodaway Rivers.

Opportunities for fishing are available on rivers, streams, lakes, and farm ponds (fig. 12). The county has 78 miles of permanently flowing streams *(6)*. The rivers and streams are inhabited by channel catfish, black and yellow bullheads, bass, crappie, carp, buffalo, sturgeon, green sunfish, and bluegill. The Missouri River borders Andrew County for approximately 11 miles. Commercial fishermen on the Missouri catch carp, carpsucker, buffalo, catfish, and a few walleye, sauger, and white bass. Sport fishermen generally fish the river for crappie, walleye, catfish, carp, and sturgeon.

The city reservoir at Savannah provides opportunities for impoundment fishing for bass, bluegill, channel catfish, and crappie. The approximately 1,200 farm ponds and small lakes in the county have been stocked with fish, including largemouth bass, channel catfish, and bluegill.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in

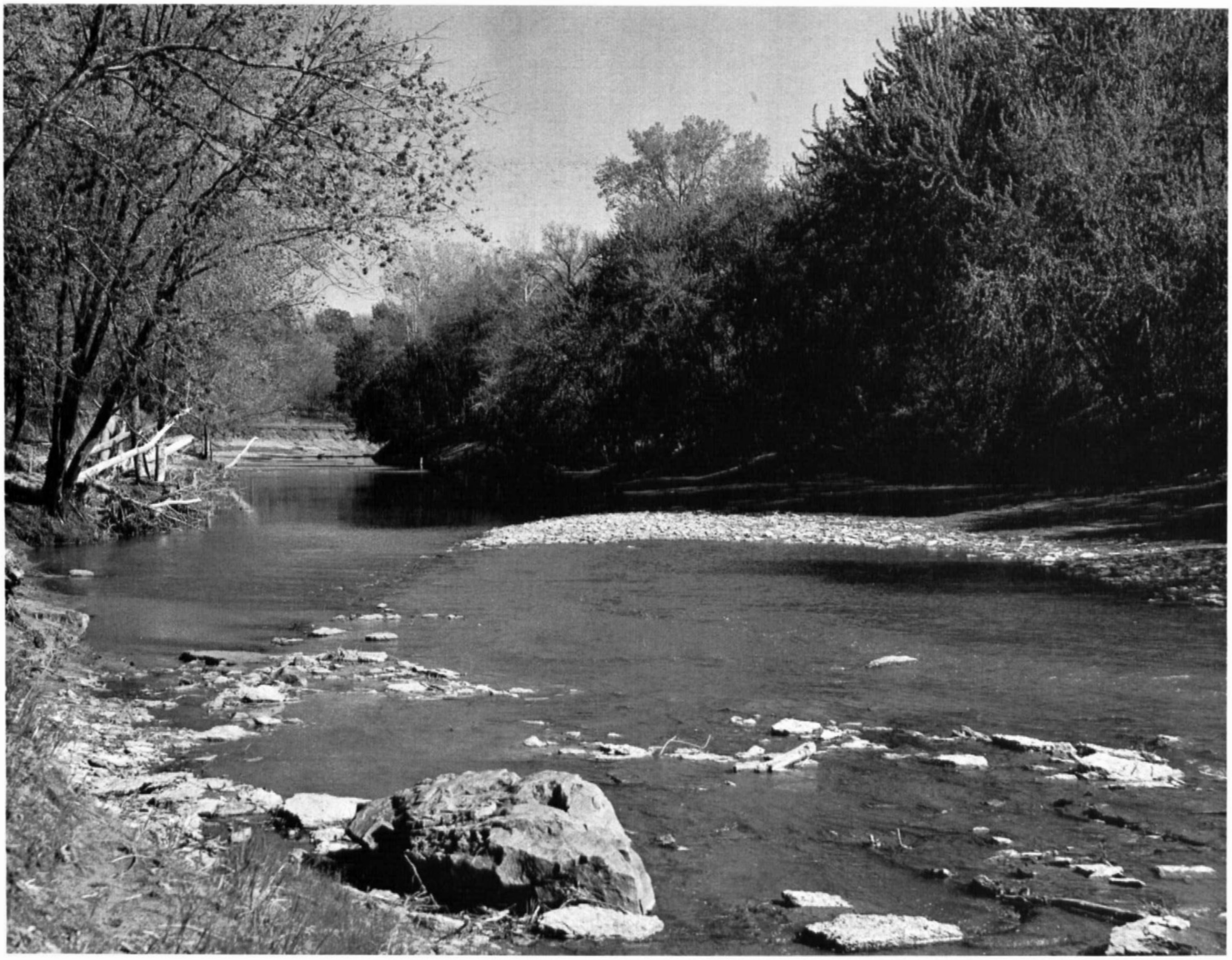


Figure 12.—An area of the Platte River, which provides wildlife habitat and recreational opportunities.

planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, soybeans, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are tall fescue, smooth bromegrass, red clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl-feeding areas, and ponds (fig. 13).

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Figure 13.—A pond used as a source of water by wildlife in Andrew County. The wild herbaceous plants provide food and cover for wildlife.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in

this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, and the shrink-swell potential can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low

embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and the shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning,

design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

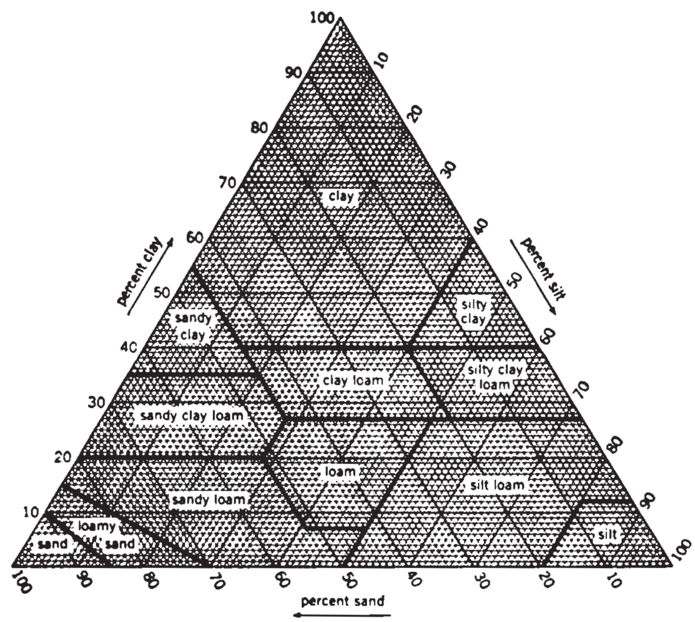


Figure 14.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 14). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified

as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available

water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the

water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(13)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. An example is Aquic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Aquic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The description of each soil horizon follows standards in the *Soil Survey Manual (11)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (13)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Albaton Series

The Albaton series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils

formed in clayey, calcareous alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Albaton silty clay, 2,150 feet north and 643 feet east of the southwest corner of sec. 2, T. 58 N., R. 36 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cg1—7 to 39 inches; stratified dark grayish brown (2.5Y 4/2), black (5Y 2/1), and very dark grayish brown (2.5Y 3/2) silty clay; few fine prominent yellowish brown (10YR 5/6) mottles in some strata; dominantly moderate fine subangular blocky structure but moderate very thin platy structure in some strata; firm; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cg2—39 to 60 inches; stratified olive gray (5Y 4/2), dark gray (5Y 4/1), and very dark gray (5Y 3/1) silty clay loam that has some strata of silt loam and silty clay; common medium prominent dark yellowish brown (10YR 4/6) mottles; dominantly moderate fine subangular blocky structure but weak very thin platy structure in some strata; firm; strong effervescence; moderately alkaline.

The Ap horizon has hue of 10YR or 2.5Y. The Cg horizon has chroma of 1 or 2. It generally has value of 4 or 5, but some strata less than 6 inches thick have value of 2 or 3. This horizon is clay or silty clay in the upper part but ranges to silty clay loam in the lower part.

Arispe Series

The Arispe series consists of deep, somewhat poorly drained soils on uplands. These soils formed in loess. Permeability is moderately slow. Slopes range from 5 to 9 percent.

The Arispe soils in this county have a thinner dark surface layer than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Arispe silty clay loam, 5 to 9 percent slopes, eroded, 1,050 feet north and 1,520 feet west of the southeast corner of sec. 36, T. 61 N., R. 34 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

Bt1—7 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam mixed with some small pockets of very dark grayish brown topsoil; few fine faint dark brown (10YR 4/3) mottles; moderate very fine subangular blocky structure; firm; few distinct clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2—11 to 18 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid; clear smooth boundary.

Bt3—18 to 29 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; many prominent clay films on faces of peds; medium acid; clear smooth boundary.

Bt4—29 to 35 inches; grayish brown (10YR 5/2) silty clay loam; many medium prominent yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; medium acid; clear smooth boundary.

BC—35 to 50 inches; light brownish gray (10YR 6/2) silty clay loam; common medium prominent yellowish brown (10YR 5/8) mottles; moderate fine prismatic structure; firm; neutral; clear smooth boundary.

2Ab—50 to 53 inches; very dark grayish brown (10YR 3/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine prismatic structure; firm; neutral; clear smooth boundary.

2Btb—53 to 60 inches; light brownish gray (10YR 6/2) silty clay loam; common medium prominent yellowish brown (10YR 5/8) mottles; common sand grains; massive; firm; neutral.

The thickness of the solum ranges from 40 to 60 inches. The Ap horizon is 7 to 10 inches thick. It has value of 2 or 3 and chroma of 1 or 2.

Armstrong Series

The Armstrong series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in clayey paleosols weathered from glacial till. Slopes range from 5 to 14 percent.

Typical pedon of Armstrong silt loam, 5 to 9 percent slopes, 600 feet south and 1,600 feet east of the northwest corner of sec. 14, T. 61 N., R. 34 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

BE—7 to 10 inches; dark brown (10YR 4/3) silty clay loam; few fine distinct dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; silt coatings on faces of peds; medium acid; clear smooth boundary.

2Bt1—10 to 14 inches; dark brown (7.5YR 4/4) clay; common fine prominent yellowish red (5YR 4/6), common fine distinct dark grayish brown (10YR 4/2), and few fine faint dark brown (7.5YR 4/2) mottles; moderate fine subangular blocky structure; firm; common faint clay films on faces of peds; few glacial pebbles; strongly acid; clear smooth boundary.

2Bt2—14 to 20 inches; yellowish brown (10YR 5/4) clay; common fine distinct dark yellowish brown (10YR 4/6) and few fine distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; firm; common distinct clay films on faces of peds; few glacial pebbles; medium acid; clear smooth boundary.

2Bt3—20 to 31 inches; brown (10YR 5/3) clay loam; common fine faint dark yellowish brown (10YR 4/4) and few fine faint dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; firm; common distinct clay films on faces of peds; few glacial pebbles; neutral; gradual smooth boundary.

2Bt4—31 to 42 inches; brown (10YR 5/3) clay loam; common fine faint light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; firm; common faint clay films on faces of peds; few glacial pebbles; neutral; gradual smooth boundary.

2C1—42 to 50 inches; light brownish gray (10YR 6/2) clay loam; few fine faint brown (10YR 5/3) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; few glacial pebbles; slight effervescence; moderately alkaline; clear smooth boundary.

2C2—50 to 60 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct light brownish gray (10YR 6/2) mottles; massive; firm; few glacial pebbles; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 42 to 60 inches. The dark surface layer is 5 to 9 inches thick. The A horizon is silt loam or clay loam. The Bt horizon has hue of 10YR, 7.5YR, or 5YR and chroma of 3 to 6. The C horizon has value of 4 to 6 and has chroma of 2 to 6.

Bremer Series

The Bremer series consists of deep, poorly drained soils on low stream terraces. These soils formed in silty alluvium. Permeability is moderately slow. Slopes range from 0 to 2 percent.

Typical pedon of Bremer silt loam, 1,200 feet south and 2,600 feet west of the northeast corner of sec. 7, T. 58 N., R. 34 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A1—8 to 13 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—13 to 19 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

A3—19 to 23 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

Bt1—23 to 30 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; common faint clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—30 to 35 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; few faint clay films on faces of peds; slightly acid; gradual smooth boundary.

Btg—35 to 45 inches; dark gray (10YR 4/1) silty clay loam; few fine distinct brown (10YR 5/3) mottles; weak medium subangular blocky structure; firm; few faint clay films on faces of peds; slightly acid; gradual smooth boundary.

BCg—45 to 60 inches; dark gray (10YR 4/1) silty clay loam; few fine distinct brown (10YR 5/3) mottles; weak fine prismatic structure; firm; slightly acid.

The thickness of the solum ranges from 40 to more

than 60 inches. The mollic epipedon is 24 to 36 inches thick.

The Ap horizon is dominantly silt loam, but silty clay loam is within the range. The upper part of the B horizon is silty clay loam or silty clay. The lower part has hue of 10YR to 5Y and value of 4 or 5.

Brussels Series

The Brussels series consists of deep, well drained soils on uplands. These soils formed in colluvium derived from limestone. Permeability is moderately slow. Slopes range from 14 to 50 percent.

Typical pedon of Brussels very flaggy silty clay loam, 14 to 50 percent slopes, 1,800 feet north and 2,230 feet east of the southwest corner of sec. 7, T. 59 N., R. 36 W.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) very flaggy silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; firm; many coarse to very fine roots; about 40 percent flagstones of limestone; slight effervescence; mildly alkaline; clear smooth boundary.

Bw1—6 to 12 inches; dark brown (10YR 3/3) very flaggy silty clay loam, dark brown (10YR 4/3) dry; moderate very fine subangular blocky structure; firm; many coarse and medium roots; about 40 percent flagstones of limestone; slight effervescence; mildly alkaline; clear smooth boundary.

Bw2—12 to 18 inches; dark brown (10YR 3/3) very flaggy silty clay loam, dark brown (10YR 4/3) dry; moderate fine subangular blocky structure; firm; common medium roots; about 40 percent flagstones of limestone; strong effervescence; mildly alkaline; clear smooth boundary.

Bw3—18 to 26 inches; dark yellowish brown (10YR 4/4) very flaggy silty clay loam; moderate very fine subangular blocky structure; firm; common coarse roots; about 40 percent flagstones of limestone; strong effervescence; mildly alkaline; clear smooth boundary.

Bw4—26 to 60 inches; dark yellowish brown (10YR 4/6) extremely flaggy silty clay loam; weak fine subangular blocky structure; firm; few medium and coarse roots; about 70 percent flagstones of limestone; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to consolidated bedrock are more than 60 inches. The mollic epipedon is 10 to 24 inches thick. Limestone fragments make up 35 to 90 percent of the solum, by volume.

The A horizon has value of 2 or 3. The Bw horizon has chroma of 2 or 3 in the upper part and value of 3 or 4 and chroma of 3 to 6 in the lower part. It is the flaggy to extremely flaggy analogs of silty clay loam or silty clay.

Colo Series

The Colo series consists of deep, poorly drained, moderately permeable soils in small upland drainageways and on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 3 percent.

Typical pedon of Colo silty clay loam, 0 to 3 percent slopes, 780 feet north and 340 feet east of the southwest corner of sec. 32, T. 59 N., R. 33 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—8 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

A2—16 to 26 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; neutral; gradual smooth boundary.

A3—26 to 39 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg—39 to 50 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine prismatic structure; firm; neutral; gradual smooth boundary.

Cg—50 to 66 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; massive; firm; neutral.

The mollic epipedon ranges from 36 to more than 60 inches in thickness. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly silty clay loam, but silt loam is within the range. The Cg horizon has hue of 5Y to 10YR, value of 3 or 4, and chroma of 1 or 2.

Gara Series

The Gara series consists of deep, moderately well drained soils on uplands. These soils formed in glacial

till. Permeability is moderately slow. Slopes range from 9 to 20 percent.

Typical pedon of Gara loam, 14 to 20 percent slopes, 2,150 feet north and 1,985 feet west of the southeast corner of sec. 26, T. 61 N., R. 34 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

E—5 to 10 inches; dark brown (10YR 4/3) loam; weak fine granular structure; friable; medium acid; clear smooth boundary.

Bt1—10 to 17 inches; dark brown (7.5YR 4/4) clay loam; moderate very fine subangular blocky structure; firm; common faint clay films on faces of peds; very strongly acid; gradual smooth boundary.

Bt2—17 to 24 inches; dark brown (7.5YR 4/4) clay loam; moderate fine subangular blocky structure; firm; common distinct clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt3—24 to 30 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; many distinct clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt4—30 to 36 inches; strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) clay loam; moderate medium subangular blocky structure; firm; many distinct dark yellowish brown (10YR 4/4) clay films on faces of peds; medium acid; clear smooth boundary.

Bt5—36 to 50 inches; yellowish brown (10YR 5/6) clay loam; few fine distinct light brownish gray (10YR 6/2) mottles; moderate fine prismatic structure; firm; common distinct dark yellowish brown (10YR 4/6) clay films on faces of peds; few fine concretions and stains of iron and manganese oxide; medium acid; clear smooth boundary.

C—50 to 70 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct light yellowish brown (10YR 6/4), common medium distinct dark yellowish brown (10YR 4/4), and few fine distinct light brownish gray (10YR 6/2) mottles; massive; firm; neutral.

The thickness of the solum ranges from 36 to 54 inches. The Ap or A horizon is 5 to 9 inches thick. It has chroma of 1 or 2. The E horizon has chroma of 2 or 3.

Haynie Series

The Haynie series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in loamy, calcareous alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Haynie very fine sandy loam, 210 feet north and 1,000 feet east of the southwest corner of sec. 26, T. 59 N., R. 36 W.

Ap—0 to 9 inches; dark brown (10YR 3/3) very fine sandy loam, brown (10YR 5/3) dry; weak fine granular structure; very friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

C—9 to 60 inches; stratified brown (10YR 5/3) and dark brown (10YR 4/3) very fine sandy loam; weak very thin platy structure; very friable; strong effervescence; moderately alkaline.

The solum, or the Ap horizon, is 6 to 9 inches thick. It has chroma of 2 or 3. It is dominantly very fine sandy loam, but silt loam is within the range. The C horizon has hue of 10YR or 2.5Y and chroma of 2 to 4. It is silt loam or very fine sandy loam.

Higginsville Series

The Higginsville series consists of deep, somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 5 to 14 percent.

The Higginsville soils in this county have a thinner dark surface layer than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Higginsville silty clay loam, 5 to 9 percent slopes, eroded, 500 feet south and 80 feet west of the northeast corner of sec. 34, T. 61 N., R. 36 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bt1—8 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint dark brown (10YR 4/3) mottles; moderate fine subangular blocky structure; firm; common faint clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2—13 to 18 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine faint dark brown (10YR 4/3) mottles; moderate fine subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid; clear smooth boundary.

Bt3—18 to 27 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct dark yellowish

brown (10YR 4/4) mottles; weak fine prismatic structure; firm; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt4—27 to 37 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) and few fine distinct dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure; firm; many prominent clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt5—37 to 46 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) and few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate medium prismatic structure; firm; many prominent clay films on faces of peds; few fine concretions of iron and manganese oxide; slightly acid; gradual smooth boundary.

BC—46 to 60 inches; grayish brown (10YR 5/2) silty clay loam; many medium distinct dark yellowish brown (10YR 4/4) and few fine distinct dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure; firm; common distinct clay films on faces of peds; few fine concretions of iron and manganese oxide; slightly acid.

The thickness of the solum ranges from 41 to more than 60 inches. The Ap horizon is 4 to 9 inches thick. It is dominantly silty clay loam, but silt loam is within the range. The Bt horizon has hue of 10YR or 2.5Y and chroma of 2 or 3 in the upper part and has value of 4 or 5 in the lower part. The C horizon, if it occurs, has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2.

Judson Series

The Judson series consists of deep, well drained, moderately permeable soils on foot slopes and in narrow upland drainageways. These soils formed in silty alluvium. Slopes range from 2 to 7 percent.

Typical pedon of Judson silt loam, 2 to 7 percent slopes, 4,000 feet north and 3,450 feet west of the southeast corner of sec. 7, T. 59 N., R. 36 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; slightly acid; clear smooth boundary.

A1—7 to 19 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; strong fine subangular blocky structure; firm; neutral; clear smooth boundary.

A2—19 to 26 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

AB—26 to 36 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark brown (10YR 3/3) crushed, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; firm; neutral; gradual smooth boundary.

Bw—36 to 48 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; weak medium subangular blocky structure; firm; neutral; gradual smooth boundary.

BC—48 to 60 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; weak fine prismatic structure; firm; neutral.

The thickness of the solum ranges from 40 to more than 60 inches. The mollic epipedon ranges from 24 to more than 60 inches in thickness.

The A horizon has chroma of 1 or 2. The Ap horizon is dominantly silt loam, but silty clay loam is within the range. The AB horizon has value and chroma of 2 or 3. Some pedons have a C horizon. The Bw, BC, and C horizons have value and chroma of 3 or 4.

Knox Series

The Knox series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 5 to 35 percent.

Typical pedon of Knox silt loam, 5 to 9 percent slopes, 130 feet south and 2,200 feet east of the northwest corner of sec. 8, T. 59 N., R. 36 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

BE—7 to 13 inches; dark brown (10YR 4/3) silty clay loam; weak very fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bt1—13 to 18 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; few faint clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2—18 to 25 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; medium acid; gradual smooth boundary.

Bt3—25 to 33 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium subangular blocky

structure; firm; common faint clay films on faces of peds; medium acid; gradual smooth boundary.

Bt4—33 to 42 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine distinct grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/8) mottles; weak fine prismatic structure; firm; few faint clay films on faces of peds; medium acid; gradual smooth boundary.

C—42 to 60 inches; dark yellowish brown (10YR 4/4) silt loam; common fine distinct grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; slightly acid.

The solum is silt loam or silty clay loam. The Ap or A horizon has chroma of 2 or 3. The Bt horizon has chroma of 3 or 4. The C horizon has value of 4 or 5 and chroma of 3 to 6. Many pedons have relict mottles in the lower part of the solum and in the C horizon.

The eroded Knox soils in this county have a thinner dark surface layer than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Ladoga Series

The Ladoga series consists of deep, moderately well drained soils on uplands. These soils formed in loess. Permeability is moderately slow. Slopes range from 2 to 9 percent.

Typical pedon of Ladoga silt loam, 2 to 5 percent slopes, 1,400 feet north and 950 feet west of the southeast corner of sec. 26, T. 61 N., R. 34 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

BE—7 to 12 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate very fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bt1—12 to 18 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; common distinct clay films on faces of peds; strongly acid; clear smooth boundary.

Bt2—18 to 26 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; firm; common prominent clay films on faces of peds; strongly acid; clear smooth boundary.

Bt3—26 to 36 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine distinct grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; firm; few fine concretions of iron and manganese oxide; common distinct clay films on faces of peds; strongly acid; clear smooth boundary.

Bt4—36 to 48 inches; dark yellowish brown (10YR 4/4) and grayish brown (10YR 5/2) silty clay loam; few medium distinct dark yellowish brown (10YR 4/6) mottles; moderate fine prismatic structure; firm; common distinct dark brown (10YR 4/3) clay films on faces of peds; common black stains; few fine concretions of iron and manganese oxide; medium acid; gradual smooth boundary.

Bt5—48 to 60 inches; dark yellowish brown (10YR 4/6) and grayish brown (10YR 5/2) silty clay loam; weak medium prismatic structure; firm; common thin distinct dark yellowish brown (10YR 4/4) clay films on faces of peds; common black stains; few fine concretions of iron and manganese oxide; medium acid.

The thickness of the solum ranges from 44 to more than 60 inches. The Ap horizon is 5 to 9 inches thick. It is silt loam or silty clay loam. The upper part of the Bt horizon has chroma of 3 or 4. The lower part has value of 4 or 5 and chroma of 2 to 6.

Lamoni Series

The Lamoni series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in clayey paleosols weathered from glacial till. Slopes range from 5 to 14 percent.

The Lamoni soils in this county have a thinner dark surface layer than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Lamoni silty clay loam, 5 to 9 percent slopes, eroded, 810 feet south and 790 feet west of the northeast corner of sec. 13, T. 61 N., R. 34 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

BA—7 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam; mixed with some very dark grayish brown (10YR 3/2) material; few fine faint dark brown (10YR 4/3) mottles; moderate very fine subangular

blocky structure; firm; slightly acid; clear smooth boundary.

2Bt1—10 to 16 inches; dark grayish brown (10YR 4/2) clay; common fine faint dark brown (10YR 4/3) and few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; firm; common faint clay films on faces of peds; few glacial pebbles; strongly acid; clear smooth boundary.

2Bt2—16 to 21 inches; dark grayish brown (10YR 4/2) clay; common fine faint dark brown (10YR 4/3) and few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; few glacial pebbles; medium acid; clear smooth boundary.

2Bt3—21 to 29 inches; brown (10YR 5/3) clay; few fine faint grayish brown (10YR 5/2) and few fine prominent yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; firm; few fine concretions of iron and manganese oxide; common distinct clay films on faces of peds; few glacial pebbles; slightly acid; gradual smooth boundary.

2Bt4—29 to 38 inches; yellowish brown (10YR 5/4) clay; few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/8) mottles; weak fine prismatic structure; firm; few fine concretions of iron and manganese oxide; few faint clay films on faces of peds; few glacial pebbles; slightly acid; clear smooth boundary.

2BC—38 to 60 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct light brownish gray (10YR 6/2) mottles; weak fine prismatic structure; firm; few fine black stains and concretions of iron and manganese oxide; few glacial pebbles; neutral.

The thickness of the solum ranges from 30 to more than 60 inches. The Ap horizon is 5 to 9 inches thick. It is dominantly silty clay loam or clay loam, but loam is within the range. The lower part of the B horizon has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 to 6.

Leta Series

The Leta series consists of deep, somewhat poorly drained soils on the flood plains along the Missouri River. These soils formed in clayey alluvium over silty and loamy, calcareous alluvium. Permeability is slow in the upper part of the profile and moderate in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Leta silty clay, 1,282 feet north and 1,600 feet east of the southwest corner of sec. 35, T. 59 N., R. 36 W.

Ap—0 to 8 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—8 to 11 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; firm; slight effervescence; mildly alkaline; clear smooth boundary.

Bg—11 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay; weak fine subangular blocky structure; firm; strong effervescence; mildly alkaline; clear smooth boundary.

2Cg1—27 to 41 inches; stratified dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) silt loam; few fine distinct gray (10YR 5/1) mottles; weak thin platy structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

2Cg2—41 to 60 inches; stratified dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) very fine sandy loam; weak thin platy structure; very friable; strong effervescence; moderately alkaline.

The solum is 20 to 30 inches thick. The mollic epipedon is 10 to 24 inches thick.

The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The 2Cg horizon has colors similar to those of the Bg horizon. It is silt loam or very fine sandy loam.

Macksburg Series

The Macksburg series consists of deep, somewhat poorly drained soils on uplands. These soils formed in loess. Permeability is moderately slow. Slopes range from 2 to 5 percent.

Typical pedon of Macksburg silty clay loam, 2 to 5 percent slopes, 2,590 feet south and 1,810 feet west of the northeast corner of sec. 29, T. 61 N., R. 33 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A1—7 to 11 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

A2—11 to 17 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; medium acid; clear smooth boundary.

Bt1—17 to 22 inches; dark grayish brown (10YR 4/2) silty clay loam; strong fine subangular blocky structure; firm; common distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; strongly acid; clear smooth boundary.

Bt2—22 to 27 inches; dark grayish brown (10YR 4/2) silty clay; common fine faint dark brown (10YR 4/3) mottles; moderate medium subangular blocky structure; firm; many prominent clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt3—27 to 34 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; firm; many prominent clay films on faces of peds; medium acid; gradual smooth boundary.

Bt4—34 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct light olive brown (2.5Y 5/4) and few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine prismatic structure; firm; few distinct clay films on faces of peds; slightly acid; clear smooth boundary.

BC—44 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; firm; slightly acid.

The solum typically is more than 60 inches thick. The mollic epipedon is 16 to 19 inches thick.

The A horizon has chroma of 1 or 2. The Ap horizon is dominantly silty clay loam, but silt loam is within the range. The Bt horizon has chroma of 2 or 3. Some pedons have a C horizon. The BC and C horizons have colors similar to those of the Bt horizon, but value is as high as 6 in some pedons.

Marshall Series

The Marshall series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 14 percent.

Typical pedon of Marshall silt loam, 2 to 5 percent slopes, 150 feet south and 55 feet east of the northwest corner of sec. 10, T. 59 N., R. 35 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A—8 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

BA—13 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark brown (10YR 3/3) crushed, brown (10YR 5/3) dry; moderate fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bw1—18 to 25 inches; brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; slightly acid; clear smooth boundary.

Bw2—25 to 32 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; slightly acid; gradual smooth boundary.

Bw3—32 to 38 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium subangular blocky structure; firm; few faint clay films on faces of peds; slightly acid; gradual smooth boundary.

Bw4—38 to 47 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine prominent strong brown (7.5YR 5/6) and common fine distinct grayish brown (10YR 5/2) relict mottles; weak fine prismatic structure breaking to weak medium subangular blocky; firm; medium acid; gradual smooth boundary.

BC—47 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine prominent strong brown (7.5YR 5/6) and common fine distinct grayish brown (10YR 5/2) relict mottles; weak medium prismatic structure; friable; medium acid.

The thickness of the solum ranges from 45 to more than 60 inches. The mollic epipedon is 10 to 19 inches thick.

The A horizon has chroma of 1 or 2. It is silt loam or silty clay loam. The Bw horizon has value of 3 or 4 in the upper part and value of 4 or 5 and chroma of 3 or 4 in the lower part. The C horizon, if it occurs, has hue of 10YR to 5Y, value of 4 or 5, and chroma of 3 or 4 and has common or many mottles with chroma of 2 or less.

The eroded Marshall soils in this county have a thinner dark surface layer than is definitive for the series. This difference, however, does not significantly affect the use and management of the soils.

Nodaway Series

The Nodaway series consists of deep, moderately

well drained, moderately permeable soils on flood plains. These soils formed in silty alluvial sediments. Slopes range from 0 to 2 percent.

Typical pedon of Nodaway silt loam, 300 feet north and 4,330 feet west of the southeast corner of sec. 10, T. 61 N., R. 34 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

C1—7 to 30 inches; stratified very dark grayish brown (10YR 3/2), grayish brown (10YR 5/2), and dark grayish brown (10YR 4/2) silt loam; appears massive but has weak bedding planes; friable; neutral; clear smooth boundary.

C2—30 to 60 inches; stratified dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) silt loam; few fine distinct yellowish brown (10YR 5/4) mottles; appears massive but has weak bedding planes; friable; neutral.

The Ap horizon is 5 to 9 inches thick.

Olmitz Series

The Olmitz series consists of deep, moderately well drained, moderately permeable soils on uplands. These soils formed in loamy alluvium. Slopes range from 3 to 9 percent.

Typical pedon of Olmitz loam, 3 to 9 percent slopes, 115 feet north and 400 feet east of the southwest corner of sec. 17, T. 58 N., R. 34 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—7 to 13 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—13 to 21 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—21 to 30 inches; dark brown (10YR 3/3) clay loam, dark brown (10YR 4/3) dry; moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw2—30 to 38 inches; dark brown (10YR 3/3) clay loam, dark brown (10YR 4/3) dry; moderate fine prismatic structure; friable; medium acid; gradual smooth boundary.

Bw3—38 to 49 inches; dark brown (10YR 4/3) clay loam; weak medium prismatic structure; friable; medium acid; gradual smooth boundary.

C—49 to 60 inches; dark yellowish brown (10YR 4/4) clay loam; massive; friable; medium acid.

The solum is 48 to more than 60 inches thick. The mollic epipedon is 32 to 40 inches thick. The A horizon has chroma of 1 or 2. The Bw horizon has chroma of 3 or 4.

Rosendale Series

The Rosendale series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from calcareous shale. Slopes range from 9 to 30 percent.

Typical pedon of Rosendale silty clay loam, 9 to 30 percent slopes, 2,670 feet south and 1,250 feet east of the northwest corner of sec. 25, T. 60 N., R. 35 W.

A—0 to 8 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; moderate very fine subangular blocky structure; friable; common fine roots; neutral; abrupt smooth boundary.

Bw1—8 to 13 inches; dark brown (10YR 4/3) silty clay loam; moderate very fine subangular blocky structure; firm; common very fine roots; neutral; clear smooth boundary.

Bw2—13 to 17 inches; dark brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; firm; common fine roots; slightly acid; clear smooth boundary.

Bw3—17 to 22 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; firm; few fine roots; medium acid; clear smooth boundary.

Bw4—22 to 27 inches; dark brown (7.5YR 4/4) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; few fine roots; few fine prominent very dark brown stains; slightly acid; clear smooth boundary.

Bw5—27 to 34 inches; light olive brown (2.5Y 5/4) silty clay loam; few fine prominent yellowish brown (10YR 5/6) and many fine distinct dark brown (10YR 4/3) mottles; weak medium subangular blocky structure; firm; few fine roots; few fine very dark brown stains; slight effervescence; mildly alkaline; gradual smooth boundary.

BC—34 to 43 inches; light yellowish brown (2.5Y 6/4) silty clay; common fine faint light olive brown (2.5Y 5/4) and few fine faint light brownish gray (2.5Y 6/2) mottles; weak fine prismatic structure; firm; few fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

C—43 to 55 inches; light olive brown (2.5Y 5/4) shaly silty clay; common fine distinct dark grayish brown (2.5Y 4/2) mottles and few fine distinct gray (2.5Y 5/0) mottles and streaks; weak medium platy structure; firm; few fine roots; about 30 percent fragments of soft shale; slight effervescence; mildly alkaline; clear smooth boundary.

Cr—55 to 70 inches; light olive brown (2.5Y 5/4), soft shale; platy rock structure; slight effervescence.

The thickness of the solum ranges from 40 to more than 60 inches. The A horizon has hue of 10YR or 2.5Y and value and chroma of 2 or 3. It is 5 to 9 inches thick. It is dominantly silty clay loam, but the range includes silt loam. The upper part of the Bw horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 3 or 4. The lower part has hue of 5Y to 7.5YR, value of 4 to 6, and chroma of 2 to 8. It is silty clay loam or silty clay. The C horizon has hue of 5Y to 10YR, value of 3 to 6, and chroma of 2 to 6.

Sarpy Series

The Sarpy series consists of deep, excessively drained, rapidly permeable soils on flood plains. These soils formed in sandy, calcareous alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Sarpy loamy fine sand, about 1,470 feet north and 550 feet east of the southwest corner of sec. 1, T. 58 N., R. 36 W.

A—0 to 7 inches; dark brown (10YR 4/3) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—7 to 43 inches; stratified dark grayish brown (10YR 4/2) and grayish brown (2.5Y 5/2) fine sand; single grain; loose; strong effervescence; moderately alkaline; clear smooth boundary.

C2—43 to 60 inches; stratified light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) loamy fine sand; single grain; loose; strong effervescence; moderately alkaline.

The solum, or the A or Ap horizon, is 6 to 9 inches thick. It has value of 3 or 4. The C horizon has chroma of 2 to 4.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained soils on uplands. These soils formed in loess. Permeability is moderately slow. Slopes range from 2 to 9 percent.

Typical pedon of Sharpsburg silt loam, 2 to 5 percent slopes, 400 feet north and 2,200 feet east of the southwest corner of sec. 14, T. 61 N., R. 34 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A—9 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

BA—13 to 19 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong fine subangular blocky structure; firm; common distinct clay films on faces of peds; medium acid; clear smooth boundary.

Bt1—19 to 28 inches; dark brown (10YR 4/3) silty clay loam; strong medium subangular blocky structure; firm; many prominent dark brown (10YR 3/3) clay films on faces of peds; strongly acid; clear smooth boundary.

Bt2—28 to 37 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; firm; common distinct dark brown (10YR 4/3) clay films on faces of peds; strongly acid; clear smooth boundary.

Bt3—37 to 45 inches; dark brown (10YR 4/3) and grayish brown (10YR 5/2) silty clay loam; moderate fine prismatic structure; firm; few distinct dark brown (10YR 4/3) clay films on faces of peds; medium acid; gradual smooth boundary.

C—45 to 60 inches; dark brown (10YR 4/3) and grayish brown (10YR 5/2) silty clay loam; massive; firm; slightly acid.

The solum is 42 to 53 inches thick. The mollic epipedon is 10 to 20 inches thick.

The Ap horizon is dominantly silt loam, but silty clay loam is within the range. The upper part of the Bt horizon has chroma of 3 or 4. The lower part has value of 4 or 5 and chroma of 3 to 6. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 2 to 6.

Shelby Series

The Shelby series consists of deep, well drained soils on uplands. These soils formed in glacial till. Permeability is moderately slow. Slopes range from 9 to 14 percent.

Typical pedon of Shelby loam, 9 to 14 percent slopes, 200 feet north and 900 feet east of the southwest corner of sec. 6, T. 61 N., R. 35 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A—9 to 12 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; medium acid; clear smooth boundary.

AB—12 to 16 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

Bt1—16 to 22 inches; dark brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; firm; common distinct clay films on faces of peds; medium acid; clear smooth boundary.

Bt2—22 to 28 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; medium acid; gradual smooth boundary.

Bt3—28 to 38 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt4—38 to 45 inches; yellowish brown (10YR 5/4) clay loam; weak medium prismatic structure; few faint clay films on faces of peds; firm; strongly acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) clay loam; massive; firm; neutral.

The thickness of the solum and the depth to free carbonates range from 30 to more than 60 inches. The mollic epipedon is 10 to 18 inches thick.

The Ap and A horizons have value of 2 or 3 and chroma of 1 or 2. The Ap horizon is dominantly loam, but clay loam is within the range. The C horizon has value of 4 or 5 and chroma of 4 to 6.

Wabash Series

The Wabash series consists of deep, very poorly drained soils on flood plains. These soils formed in clayey alluvium. Permeability is very slow. Slopes range from 0 to 2 percent.

Typical pedon of Wabash silty clay, 377 feet north and 1,585 feet west of the southeast corner of sec. 22, T. 61 N., R. 35 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine granular structure; firm; slightly acid; abrupt smooth boundary.

A1—6 to 11 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

A2—11 to 30 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg1—30 to 48 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; some large spots and streaks of dark gray (5Y 4/1) material; weak medium subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg2—48 to 66 inches; dark gray (5Y 4/1) silty clay; few streaks of very dark gray (10YR 3/1) material; moderate medium subangular blocky structure; firm; neutral.

The mollic epipedon is 36 to 50 inches thick. The lower part of the Bg horizon has hue of 5Y to 10YR and value of 4 or 5.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils formed in silty and clayey alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Zook silty clay loam, 240 feet north and 3,800 feet west of the southeast corner of sec. 10, T. 61 N., R. 34 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A1—8 to 15 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; firm; medium acid; clear smooth boundary.

A2—15 to 23 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak medium

subangular blocky structure; firm; medium acid; gradual smooth boundary.

A3—23 to 36 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; slightly acid; gradual smooth boundary.

Bg1—36 to 49 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct dark brown (7.5YR 3/2) mottles; weak fine prismatic structure; firm; slightly acid; gradual smooth boundary.

Bg2—49 to 60 inches; dark gray (10YR 4/1) silty clay; few fine distinct dark brown (7.5YR 3/2) mottles; weak medium prismatic structure; firm; neutral.

The mollic epipedon is 36 to 50 inches thick. The Bg horizon has hue of 5Y to 10YR and value of 3 to 5. It is silty clay loam or silty clay.

Formation of the Soils

Soil forms through processes that act on accumulated or deposited geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil that has distinct horizons. Some time is always required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineral composition of the soil. The soils in Andrew County formed in loess, glacial till, alluvium, residual material, or a combination of these.

Loess is wind-deposited material probably derived from the larger flood plains. It remains on most of the wider ridges in the county. It is as much as 70 feet thick in some areas. Arispe, Higginsville, Knox, Ladoga, Macksburg, Marshall, and Sharpsburg soils formed in loess.

Before the loess was deposited, thick layers of glacial till were deposited over the bedrock in the county. The till is generally a yellowish brown, heterogeneous mass of sand, silt, clay, and rocks ranging in size from small pebbles to boulders. It does not occur in some areas but ranges to more than 300 feet in thickness in others. In most areas soils formed in the glacial till during long interglacial ages. Many of these soils were buried under thick deposits of loess. In some areas, however, these old soils are covered with only very thin layers of loess or loamy sediments. Armstrong and Lamoni soils formed in paleosols weathered from glacial till. They have retained distinct characteristics of the older original soils. In the steeper areas unweathered glacial material was later exposed by geologic erosion. Gara and Shelby soils formed in this material.

Alluvium is water-transported soil material that was deposited on nearly level flood plains along streams. Most of this material was eroded from the surrounding upland soils. The material ranges from clay and silt to fine sand. Colo, Nodaway, and Zook are examples of soils that formed in alluvium.

The residuum in Andrew County is material weathered from shale and limestone beds. Brussels soils formed in colluvium weathered from limestone, and Rosendale soils formed in material weathered from shale.

Climate

Climate has been an important factor affecting the formation of soils in Andrew County. Variations in the climate have affected the other soil-forming factors in the county.

The current climate is subhumid midcontinental. It has apparently changed little in recent history. It has been drier than that of previous periods and has favored the growth of native prairie grasses. Many of the soils in the county have a dark upper layer, which

indicates that they formed under prairie vegetation. Marshall, Macksburg, and Shelby soils are examples.

The climatic period before the current one was cool and moist *(8)*. This climate favored the growth of forest vegetation. During the following drier period, the extent of the forest vegetation decreased in all areas, except for those near streams. Soils that formed under both prairie and forest vegetation have a moderately thick, dark surface layer. Armstrong, Gara, Knox, Ladoga, and Rosendale soils are examples.

The glacial periods resulted from changes in climate. Thousands of years of cooler temperatures caused the formation of massive glaciers, which covered northern Missouri at one time. Later, warmer temperatures resulted in catastrophic geologic erosion and the deposition of the loess that covered most of the county at one time. Because extreme changes in climate occur very slowly, there were long intermediate periods characterized by different types of vegetation. Soils formed on the surface and were later covered by loess, truncated, mixed by erosion, or completely eroded away. Some soils formed mainly in these old truncated or weathered surfaces. Armstrong and Lamoni soils are examples.

The prevailing winds currently are from the southwest. Most of the loess, therefore, was blown in a northeasterly direction, probably from the flood plains along the Missouri River and other large streams. The distance that the loess was carried depends on the particle size. The smaller, lighter particles, such as clay, were carried farther from the source, and the larger, heavier particles, such as silt, were deposited closer to the source. As a result, the thickness of the loess decreases as the distance from the source increases.

Local conditions can modify the influence of the general climate in a region. South-facing slopes, for example, are warmer and drier than north-facing slopes. Poorly drained soils in low areas on bottom land stay wetter and cooler longer than soils in the higher adjacent areas. These local variations account for some of the differences among the soils in the county.

Plants and Animals

Plants, burrowing animals, insects, bacteria, and fungi have important effects on the formation of soils. They affect the content of organic matter and plant nutrients, soil structure, and the porosity of the soils.

Many of the soils in Andrew County formed mainly under tall prairie grasses. These soils, which are generally known as prairie soils, have a thick, dark surface layer that has a high content of organic matter because of abundant bacteria and decaying fine grass roots. Arispe, Higginsville, Judson, Lamoni, Macksburg, Marshall, Olmitz, Sharpsburg, and Shelby soils formed under prairie grasses on uplands.

Soils that formed under forest vegetation have a surface layer that is thinner than that of soils that formed under grasses. Armstrong, Gara, Knox, Ladoga, and Rosendale soils formed under both grasses and forest vegetation. These soils have properties intermediate between those of soils that formed under grasses and those of soils that formed under forest vegetation.

Worms, insects, burrowing animals, and large animals affect soil formation. The effects of bacteria and fungi, however, are more significant than the effects of animals. Bacteria and fungi cause the rotting of organic material, improve tilth, and fix nitrogen in the soils. The population of soil organisms is directly related to the rate at which organic matter decomposes in the soil. Differences in vegetation affect the kinds of organisms and their activities.

Human activities have greatly affected the soils in the county. Intensive cultivation and overgrazing have resulted in severe erosion in many areas. All of the topsoil (as much as 16 inches) has been lost in some areas. Most of the cropland is still eroding at an excessive rate.

Relief

Relief influences soil formation mainly through its effect on drainage, runoff, and erosion. To some extent, its effect on exposure to sunlight and the wind also is important.

The amount of water entering and passing through the soil depends on the slope, permeability, and the amount and intensity of rainfall. On steep soils, runoff is rapid and very little water passes through the profile. Consequently, distinct horizons develop at a slow rate. On nearly level or gently sloping soils, runoff is slow and most of the water passes through the profile. As a result, these soils are characterized by maximum profile development.

South-facing slopes are exposed to more direct sunlight than north-facing slopes and thus warm and dry more rapidly and support different native vegetation. Also, they freeze and thaw more frequently than north-facing slopes, which tend to stay frozen longer. Because of the more frequent freeze-thaw cycles, soils on south-facing slopes are weathered to a greater depth and are subject to accelerated geologic erosion, which tends to level the slopes.

Soils in concave areas, such as the somewhat poorly drained Arispe, Armstrong, Higginsville, and Lamoni soils, are generally wet because runoff concentrates on the surface. The amount of water that collects on the surface and passes through the soils is greater than the amount in convex areas.

Soils in convex areas are drier than soils in concave areas because runoff is dispersed on the surface. These soils generally are well drained or moderately well drained. Examples are Gara, Knox, Ladoga, Marshall, Sharpsburg, and Shelby soils.

Time

The degree of profile development reflects the length of time that the parent material has been in place and has been subject to weathering. Young soils show very little evidence of profile development, or horizon differentiation. Old soils are characterized by the movement of clay, leaching, and distinct horizons.

The youngest soils in Andrew County are those that formed in alluvium. Nodaway soils, for example, do not show any evidence of profile development. Alluvial material is added to the surface nearly every year. Bremer soils, which are on terraces, are the oldest alluvial soils. They show a moderate degree of profile development.

The soils on uplands are older than the soils on flood plains and terraces. The oldest parent material in the county weathered from interbedded limestone and shale. Brussels and Rosendale soils formed in this material.

Glacial material was deposited on top of the limestone and shale. Armstrong and Lamoni soils formed in glacial material that was highly weathered before loess was deposited. They are the oldest glacial soils in the county. Gara and Shelby soils also formed in the glacial till, but they are younger than Armstrong and Lamoni soils. They formed in material that was dissected by geologic erosion after the glacial period.

The most recent material in the uplands is the loess that was deposited on top of the glacial material. Arispe, Higginsville, Knox, Ladoga, Macksburg, Marshall, and Sharpsburg soils formed in this material.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Essex, Burton L. 1974. Forest area in Missouri counties, 1972. U.S. Dep. Agric., Forest Serv. Res. Note NC-182, 4 pp.

(4) Goodspeed Publishing Co. 1888. History of Andrew and DeKalb Counties, Missouri.

(5) Missouri Department of Natural Resources, Division of Parks and Recreation. 1976. Missouri statewide comprehensive outdoor recreation plan.

(6) Nagel, Werner, ed. and comp. 1970. Conservation contrasts. Missouri Dep. of Conserv., 453 pp., illus.

(7) National Association of Conservation Districts. NACD nationwide outdoor recreation inventory—Missouri. (Unpublished data assembled in 1974; available in local offices of the Soil Conservation Service)

(8) Ruhe, R.V., R.B. Daniels, and J.G. Cady. 1967. Landscape evolution and soil formation in southwestern Iowa. U.S. Dep. Agric. Tech. Bull. 1349, 242 pp., illus.

(9) State Interagency Council for Outdoor Recreation. 1980. Missouri statewide comprehensive outdoor recreation plan. 127 pp., illus.

(10) Sweet, A.T. 1925. Soil survey of Andrew County, Missouri. U.S. Dep. Agric., Bur. of Soils, 34 pp., illus.

(11) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(12) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(13) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(14) United States Department of Agriculture, Soil Conservation Service. National resources inventory. (Available in the State Office of the Soil Conservation Service at Columbia, Missouri)

(15) United States Department of Commerce, Bureau of the Census. 1982. 1980 census of population. PC80-1-D27.

(16) United States Department of Commerce, Bureau of the Census. 1983. 1982 census of agriculture—preliminary report. AC82-A-29-003(P), 4 pp.

Glossary

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay,

less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other

elements in the profile and in gray colors and mottles.

Grassed back slope terrace. A terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. During construction, soil material is pushed up from the lower side, resulting in a steep back slope that is sown to grass. The areas between the terraces are less sloping than they were before construction.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon,

hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. In this soil survey, the content of organic matter in the Ap horizon or in the upper 10 inches is described as *very low* if it is less than 0.5 percent, *low* if 0.5 to 2.0 percent, *moderate* if 2.0 to 3.0 percent, *high* if 3.0 to 5.0 percent, and *very high* if 5.0 percent or more.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered

surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1952-79 at St. Joseph, Missouri)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	34.5	14.7	24.6	62	-14	0	0.98	0.25	1.55	3	5.9
February----	41.6	20.9	31.3	70	-7	16	.97	.29	1.50	3	4.2
March-------	52.2	30.3	41.3	83	3	66	2.28	.77	3.52	5	4.9
April-------	66.5	43.1	54.8	90	22	188	3.09	1.76	4.27	6	.6
May---------	76.3	53.7	65.0	92	33	470	4.64	2.55	6.47	7	.0
June--------	85.5	63.3	74.4	99	46	732	4.89	2.54	6.94	8	.0
July--------	89.4	67.3	78.4	102	50	880	3.83	1.16	5.98	6	.0
August------	87.2	64.7	76.0	100	48	806	3.89	1.63	5.80	6	.0
September---	79.7	55.9	67.8	96	36	534	4.11	1.47	6.29	6	.0
October-----	69.8	44.2	57.0	91	24	253	2.68	.53	4.38	5	.0
November----	53.1	31.7	42.4	78	10	23	1.66	.24	2.72	3	.6
December----	40.4	21.7	31.1	66	-6	0	1.04	.35	1.60	3	4.3
Yearly:											
Average---	64.7	42.6	53.7	---	---	---	---	---	---	---	---
Extreme---	---	---	---	102	-15	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,968	34.06	26.09	41.53	61	20.5

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1952-79 at St. Joseph, Missouri)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 10	Apr. 21	May 4
2 years in 10 later than--	Apr. 5	Apr. 16	Apr. 29
5 years in 10 later than--	Mar. 25	Apr. 6	Apr. 19
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 23	Oct. 12	Sept. 30
2 years in 10 earlier than--	Oct. 28	Oct. 17	Oct. 5
5 years in 10 earlier than--	Nov. 6	Oct. 27	Oct. 16

TABLE 3.--GROWING SEASON

(Recorded in the period 1952-79 at St. Joseph, Missouri)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	203	181	157
8 years in 10	211	189	165
5 years in 10	226	204	179
2 years in 10	242	219	193
1 year in 10	250	227	201

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1B	Marshall silt loam, 2 to 5 percent slopes	12,700	4.6
1C2	Marshall silty clay loam, 5 to 9 percent slopes, eroded	14,700	5.3
1D2	Marshall silty clay loam, 9 to 14 percent slopes, eroded	2,350	0.8
2C	Knox silt loam, 5 to 9 percent slopes	15,200	5.4
2D2	Knox silty clay loam, 9 to 14 percent slopes, eroded	13,100	4.7
2E2	Knox silty clay loam, 14 to 20 percent slopes, eroded	5,200	1.9
2F2	Knox silt loam, 20 to 35 percent slopes, eroded	2,650	1.0
6C2	Arispe silty clay loam, 5 to 9 percent slopes, eroded	15,300	5.5
7B	Sharpsburg silt loam, 2 to 5 percent slopes	7,000	2.5
7C	Sharpsburg silt loam, 5 to 9 percent slopes	1,750	0.6
8B	Macksburg silty clay loam, 2 to 5 percent slopes	8,700	3.1
9C2	Higginsville silty clay loam, 5 to 9 percent slopes, eroded	12,800	4.6
9D2	Higginsville silty clay loam, 9 to 14 percent slopes, eroded	5,900	2.1
16B	Ladoga silt loam, 2 to 5 percent slopes	660	0.2
16C2	Ladoga silty clay loam, 5 to 9 percent slopes, eroded	2,250	0.8
23	Bremer silt loam	1,100	0.4
26E	Rosendale silty clay loam, 9 to 30 percent slopes	7,300	2.6
29F	Brussels very flaggy silty clay loam, 14 to 50 percent slopes	14,500	5.2
33C	Armstrong silt loam, 5 to 9 percent slopes	2,950	1.1
33D2	Armstrong clay loam, 9 to 14 percent slopes, eroded	11,000	3.9
36C	Olmitz loam, 3 to 9 percent slopes	640	0.2
37D	Gara loam, 9 to 14 percent slopes	10,600	3.8
37E	Gara loam, 14 to 20 percent slopes	4,600	1.6
42C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded	28,500	10.2
42D2	Lamoni clay loam, 9 to 14 percent slopes, eroded	11,800	4.2
44D	Shelby loam, 9 to 14 percent slopes	7,100	2.5
53B	Judson silt loam, 2 to 7 percent slopes	4,000	1.4
55A	Colo silty clay loam, 0 to 3 percent slopes	22,400	8.0
56	Zook silty clay loam	6,600	2.4
58	Wabash silty clay	810	0.3
61	Nodaway silt loam	15,800	5.7
71	Albaton silty clay	700	0.3
72	Haynie very fine sandy loam	2,950	1.1
76	Leta silty clay	3,750	1.3
80	Sarpy loamy fine sand	340	0.1
99	Pits, quarries	650	0.2
	Water	1,093	0.4
	Total	279,443	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
1B	Marshall silt loam, 2 to 5 percent slopes
7B	Sharpsburg silt loam, 2 to 5 percent slopes
8B	Macksburg silty clay loam, 2 to 5 percent slopes
16B	Ladoga silt loam, 2 to 5 percent slopes
23	Bremer silt loam (where drained)
53B	Judson silt loam, 2 to 7 percent slopes
55A	Colo silty clay loam, 0 to 3 percent slopes (where drained)
56	Zook silty clay loam (where drained)
58	Wabash silty clay (where drained)
61	Nodaway silt loam
71	Albaton silty clay (where drained)
72	Haynie very fine sandy loam
76	Leta silty clay

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchardgrass-alfalfa hay	Smooth bromegrass	Big bluestem
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
1B-------------- Marshall	IIe	115	42	100	47	4.3	8.6	8.6
1C2------------- Marshall	IIIe	109	41	95	44	4.1	8.2	8.2
1D2------------- Marshall	IIIe	102	38	89	41	3.8	7.6	7.6
2C-------------- Knox	IIIe	105	38	90	42	3.9	7.8	7.8
2D2------------- Knox	IIIe	89	33	78	37	3.3	6.6	6.6
2E2------------- Knox	IVe	78	28	68	31	2.9	5.8	5.8
2F2------------- Knox	VIe	---	---	---	---	2.8	5.6	5.6
6C2------------- Arispe	IIIe	102	38	89	42	3.8	7.6	7.6
7B-------------- Sharpsburg	IIe	118	44	103	48	4.4	8.8	8.8
7C-------------- Sharpsburg	IIIe	114	41	99	46	4.2	8.4	8.4
8B-------------- Macksburg	IIe	124	46	110	50	4.6	9.2	9.2
9C2------------- Higginsville	IIIe	112	41	96	45	4.1	8.2	8.2
9D2------------- Higginsville	IIIe	94	34	83	38	3.5	7.0	7.0
16B------------- Ladoga	IIe	106	39	90	43	3.9	7.8	7.8
16C2------------ Ladoga	IIIe	100	33	80	39	3.4	7.2	7.2
23-------------- Bremer	IIw	107	39	92	43	3.9	7.8	7.8
26E------------- Rosendale	VIe	---	---	---	---	2.5	5.0	5.0
29F------------- Brussels	VIIs	---	---	---	---	---	1.5	3.0
33C------------- Armstrong	IIIe	83	31	73	34	3.1	6.2	6.2

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchardgrass-alfalfa hay	Smooth bromegrass	Big bluestem
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
33D2------------ Armstrong	IVe	67	25	59	27	2.5	5.0	5.0
36C------------- Olmitz	IIIe	114	41	99	46	4.2	8.4	8.4
37D------------- Gara	IVe	86	31	75	35	3.2	6.4	6.4
37E------------- Gara	VIe	---	---	---	---	2.3	4.6	4.6
42C2------------ Lamoni	IIIe	82	31	73	34	3.1	6.2	6.2
42D2------------ Lamoni	IVe	76	29	67	31	2.8	5.6	5.6
44D------------- Shelby	IIIe	92	33	80	37	3.4	6.8	6.8
53B------------- Judson	IIe	122	46	107	50	4.5	9.0	9.0
55A------------- Colo	IIw	105	38	90	42	3.9	7.8	7.8
56-------------- Zook	IIw	97	36	84	39	3.6	7.2	7.2
58-------------- Wabash	IIIw	75	28	65	30	2.8	5.6	5.6
61-------------- Nodaway	IIw	118	44	103	48	4.4	8.8	8.8
71-------------- Albaton	IIIw	80	30	71	33	2.9	5.8	5.8
72-------------- Haynie	I	115	42	100	47	4.3	8.6	8.6
76-------------- Leta	IIw	92	33	80	37	3.4	6.8	6.8
80-------------- Sarpy	IVs	---	---	47	20	2.0	4.0	4.0
99**. Pits								

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
2C, 2D2--------- Knox	3A	Slight	Slight	Slight	Slight	White oak-----------	65	48	Northern red oak, green ash, black walnut.
2E2, 2F2-------- Knox	3R	Moderate	Moderate	Moderate	Slight	White oak-----------	65	48	Northern red oak, green ash, black walnut.
16B, 16C2------- Ladoga	4A	Slight	Slight	Slight	Slight	White oak----------- Northern red oak----	75 75	57 57	White oak, northern red oak, black walnut.
23-------------- Bremer	7W	Slight	Severe	Moderate	Moderate	Eastern cottonwood-- Silver maple--------	90 ---	103 ---	American sycamore, hackberry, green ash, eastern cottonwood, silver maple.
26E------------- Rosendale	3R	Moderate	Moderate	Slight	Slight	White oak----------- Northern red oak---- Shagbark hickory----	58 --- ---	41 --- ---	Northern red oak.
29F------------- Brussels	3R	Moderate	Moderate	Moderate	Slight	White oak----------- Northern red oak---- Black oak----------- Shagbark hickory---- Black walnut--------	60 65 --- --- ---	43 43 --- --- ---	Northern red oak, white oak.
33C, 33D2------- Armstrong	3C	Slight	Slight	Severe	Severe	White oak----------- Northern red oak----	55 55	38 38	Northern red oak, white oak.
37D------------- Gara	3A	Slight	Slight	Slight	Slight	White oak----------- Northern red oak----	55 55	38 38	White oak, northern red oak, white ash.
37E------------- Gara	3R	Moderate	Moderate	Slight	Slight	White oak----------- Northern red oak----	55 55	38 38	White oak, northern red oak, white ash.
58-------------- Wabash	4W	Slight	Severe	Severe	Moderate	Pin oak-------------	75	57	Pin oak, pecan, eastern cottonwood.

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
61-------------- Nodaway	9A	Slight	Slight	Slight	Slight	Eastern cottonwood--	100	128	Black walnut, eastern cottonwood, American sycamore, green ash, white oak.
72-------------- Haynie	11A	Slight	Slight	Slight	Slight	Eastern cottonwood-- American sycamore--- Black walnut-------- Green ash-----------	110 110 --- ---	156 --- --- ---	Black walnut, eastern cottonwood.
76-------------- Leta	7C	Slight	Moderate	Severe	Severe	Eastern cottonwood-- Silver maple-------- Black willow--------	90 --- ---	103 --- ---	Sweetgum, pecan, eastern cottonwood, silver maple, green ash.
80-------------- Sarpy	8S	Slight	Slight	Severe	Slight	Eastern cottonwood-- Silver maple--------	95 ---	116 ---	Eastern cottonwood, American sycamore.

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1B, 1C2, 1D2------ Marshall	---	Autumn olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
2C, 2D2, 2E2, 2F2- Knox	---	Amur honeysuckle, autumn olive, lilac, Amur maple.	Hackberry, eastern redcedar, green ash, bur oak, Russian olive.	Austrian pine, eastern white pine, honeylocust.	---
6C2--------------- Arispe	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
7B, 7C------------ Sharpsburg	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	White fir, blue spruce, northern whitecedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
8B---------------- Macksburg	---	American cranberrybush, Amur honeysuckle, Amur privet, silky dogwood.	Northern whitecedar, blue spruce, Washington hawthorn, white fir, Austrian pine.	Norway spruce-----	Eastern white pine, pin oak.
9C2, 9D2---------- Higginsville	---	Amur honeysuckle, lilac, autumn olive, Amur maple.	Eastern redcedar	Austrian pine, eastern white pine, honeylocust, hackberry, green ash, pin oak.	Eastern cottonwood.
16B, 16C2--------- Ladoga	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern whitecedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
23---------------- Bremer	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.
26E--------------- Rosendale	Lilac-------------	Amur honeysuckle, autumn olive, Manchurian crabapple, Siberian peashrub.	Russian olive, Austrian pine, eastern redcedar, jack pine, hackberry, green ash.	Honeylocust-------	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
29F: Brussels	Amur honeysuckle, fragrant sumac, lilac.	Autumn olive	Austrian pine, Russian olive, eastern redcedar, green ash, honeylocust, common hackberry, bur oak.	Siberian elm	---
33C, 33D2: Armstrong	Lilac	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn olive.	Austrian pine, eastern redcedar, green ash, jack pine, Russian olive, hackberry.	Honeylocust	---
36C: Olmitz	---	Amur maple, lilac, autumn olive, Amur honeysuckle.	Eastern redcedar, Russian olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
37D, 37E: Gara	---	Autumn olive, lilac, Amur honeysuckle, Amur maple.	Bur oak, eastern redcedar, green ash, Russian olive, hackberry.	Honeylocust, eastern white pine, Austrian pine.	---
42C2, 42D2: Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, Osageorange.	Eastern white pine, pin oak.	---
44D: Shelby	---	Autumn olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
53B: Judson	---	Amur honeysuckle, Amur maple, autumn olive, lilac.	Hackberry, bur oak, green ash, Russian olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
55A: Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
56: Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
58 Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
61 Nodaway	---	Amur honeysuckle, autumn olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
71 Albaton	Blackhaw	Siberian peashrub, Tatarian honeysuckle.	Osageorange, Russian olive, eastern redcedar, Washington hawthorn.	Hackberry, bur oak, honeylocust.	Eastern cottonwood, green ash.
72 Haynie	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Russian olive, Osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
76 Leta	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Osageorange, Russian olive, Washington hawthorn.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.
80 Sarpy	Blackhaw	Tatarian honeysuckle, Siberian peashrub, Washington hawthorn.	Eastern redcedar, Russian olive, Osageorange.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.
99*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1B: Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
1C2: Marshall	Slight	Slight	Severe: slope.	Slight	Slight.
1D2: Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
2C: Knox	Slight	Slight	Severe: slope.	Slight	Slight.
2D2: Knox	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
2E2: Knox	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
2F2: Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
6C2: Arispe	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Slight	Slight.
7B: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
7C: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
8B: Macksburg	Moderate: percs slowly, wetness.	Moderate: percs slowly, wetness.	Moderate: slope, wetness, percs slowly.	Slight	Slight.
9C2: Higginsville	Moderate: wetness.	Moderate: wetness.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
9D2: Higginsville	Moderate: slope, wetness.	Moderate: slope, wetness.	Severe: slope.	Severe: erodes easily.	Moderate: wetness, slope.
16B: Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
16C2: Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
23: Bremer	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
26E: Rosendale	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
29F Brussels	Severe: slope, large stones.	Severe: slope, large stones.	Severe: large stones, slope.	Severe: large stones, slope.	Severe: large stones, slope.
33C Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
33D2 Armstrong	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
36C Olmitz	Slight	Slight	Severe: slope.	Slight	Slight.
37D Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
37E Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
42C2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
42D2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
44D Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
53B Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
55A Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
56 Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
58 Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
61 Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
71 Albaton	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
72 Haynie	Severe: flooding.	Slight	Slight	Slight	Slight.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
76--------------------Leta	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
80--------------------Sarpy	Severe: flooding.	Slight----------	Slight----------	Slight----------	Moderate: droughty.
99*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1B----------------- Marshall	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1C2, 1D2----------- Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
2C, 2D2------------ Knox	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
2E2---------------- Knox	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
2F2---------------- Knox	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
6C2---------------- Arispe	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
7B----------------- Sharpsburg	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
7C----------------- Sharpsburg	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
8B----------------- Macksburg	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
9C2---------------- Higginsville	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
9D2---------------- Higginsville	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
16B---------------- Ladoga	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
16C2--------------- Ladoga	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
23----------------- Bremer	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
26E---------------- Rosendale	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
29F---------------- Brussels	Very poor.	Very poor.	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
33C, 33D2---------- Armstrong	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
36C---------------- Olmitz	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
37D---------------- Gara	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
37E----------------- Gara	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
42C2, 42D2---------- Lamoni	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
44D----------------- Shelby	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
53B----------------- Judson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
55A----------------- Colo	Good	Fair	Good	Fair	Fair	Good	Fair	Fair	Fair	Good.
56------------------ Zook	Good	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
58------------------ Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
61------------------ Nodaway	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Fair.
71------------------ Albaton	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
72------------------ Haynie	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
76------------------ Leta	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
80------------------ Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
99*. Pits										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1B: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
1C2: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
1D2: Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
2C: Knox	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
2D2: Knox	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
2E2, 2F2: Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
6C2: Arispe	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
7B: Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
7C: Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
8B: Macksburg	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
9C2: Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.	Moderate: wetness.
9D2: Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: wetness.	Severe: slope.	Severe: low strength, frost action.	Moderate: wetness, slope.
16B: Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
16C2 Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
23 Bremer	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: shrink-swell, low strength.	Moderate: wetness.
26E Rosendale	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Slight.
29F Brussels	Severe: large stones, slope.	Severe: slope, large stones.	Severe: slope, large stones.	Severe: slope, large stones.	Severe: low strength, slope, large stones.	Severe: large stones, slope.
33C Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, frost action.	Moderate: wetness.
33D2 Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength, frost action.	Moderate: slope, wetness.
36C Olmitz	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
37D Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
37E Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
42C2 Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
42D2 Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
44D Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
53B Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
55A Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
56. Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
58. Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, too clayey.
61. Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
71. Albaton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength.	Severe: too clayey.
72. Haynie	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
76. Leta	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Severe: too clayey.
80. Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty.
99*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1B Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
1C2 Marshall	Slight	Severe: slope.	Slight	Slight	Good.
1D2 Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
2C Knox	Slight	Severe: slope.	Slight	Slight	Good.
2D2 Knox	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
2E2, 2F2 Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
6C2 Arispe	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
7B Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
7C Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
8B Macksburg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
9C2 Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
9D2 Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness, slope.	Fair: too clayey, slope, wetness.
16B Ladoga	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
16C2 Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
23 Bremer	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
26E----------------- Rosendale	Severe: percs slowly, wetness, slope.	Severe: slope, wetness.	Severe: seepage, slope, too clayey.	Severe: slope.	Poor: too clayey, slope.
29F----------------- Brussels	Severe: percs slowly, slope, large stones.	Severe: slope, large stones.	Severe: slope, too clayey, large stones.	Severe: slope.	Poor: too clayey, large stones, slope.
33C, 33D2----------- Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
36C----------------- Olmitz	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
37D----------------- Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
37E----------------- Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
42C2, 42D2---------- Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
44D----------------- Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
53B----------------- Judson	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
55A----------------- Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
56------------------ Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
58------------------ Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
61------------------ Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
71------------------ Albaton	Severe: wetness, percs slowly.	Slight-----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
72------------------ Haynie	Moderate: flooding.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
76------------------ Leta	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
80------------------ Sarpy	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
99*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1B, 1C2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1D2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
2C Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
2D2 Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope, thin layer.
2E2 Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
2F2 Knox	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
6C2 Arispe	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
7B, 7C Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
8B Macksburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor. thin layer.
9C2 Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
9D2 Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
16B, 16C2 Ladoga	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
23 Bremer	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
26E Rosendale	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
29F Brussels	Poor: low strength, large stones, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: too clayey, large stones, area reclaim.
33C, 33D2 Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
36C------------------- Olmitz	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
37D------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
37E------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
42C2, 42D2------------ Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
44D------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
53B------------------- Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
55A------------------- Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
56-------------------- Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
58-------------------- Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
61-------------------- Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
71-------------------- Albaton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
72-------------------- Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
76-------------------- Leta	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
80-------------------- Sarpy	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: too sandy.
99*. Pits				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
1B, 1C2 Marshall	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
1D2 Marshall	Severe: slope.	Slight	Deep to water	Slope	Erodes easily, slope.	Slope, erodes easily.
2C Knox	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
2D2, 2E2, 2F2 Knox	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
6C2 Arispe	Moderate: seepage, slope.	Moderate: hard to pack, wetness.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
7B, 7C Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
8B Macksburg	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
9C2 Higginsville	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
9D2 Higginsville	Severe: slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Slope, erodes easily, wetness.	Slope, erodes easily.
16B, 16C2 Ladoga	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
23 Bremer	Slight	Severe: wetness, hard to pack.	Frost action	Wetness	Wetness	Wetness.
26E Rosendale	Severe: slope.	Moderate: thin layer, piping.	Deep to water	Slope, percs slowly.	Slope	Slope.
29F Brussels	Severe: slope.	Severe: large stones.	Deep to water	Slope, large stones, droughty.	Slope, large stones.	Large stones, slope, droughty.
33C Armstrong	Moderate: slope.	Moderate: wetness, hard to pack.	Slope, percs slowly, frost action.	Slope, wetness, percs slowly.	Percs slowly, wetness.	Percs slowly, wetness.
33D2 Armstrong	Severe: slope.	Moderate: wetness, hard to pack.	Slope, percs slowly, frost action.	Slope, wetness, percs slowly.	Slope, percs slowly, wetness.	Percs slowly, slope, wetness.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
36C Olmitz	Moderate: seepage, slope.	Slight	Deep to water	Slope	Favorable	Favorable.
37D, 37E Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
42C2 Lamoni	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, slope.	Percs slowly, wetness.	Percs slowly, wetness.
42D2 Lamoni	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.
44D Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
53B Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
55A Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
56 Zook	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
58 Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
61 Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
71 Albaton	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
72 Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
76 Leta	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness	Wetness, percs slowly.
80 Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
99*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1B--------------- Marshall	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-40	5-15
	8-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
1C2, 1D2--------- Marshall	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	7-49	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	49-65	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
2C--------------- Knox	0-7	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	90-100	20-35	2-15
	7-42	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	42-60	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
2D2, 2E2--------- Knox	0-5	Silty clay loam	CL	A-6	0	100	100	95-100	95-100	30-35	10-15
	5-44	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	44-70	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
2F2-------------- Knox	0-4	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	90-100	20-35	2-15
	4-19	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	19-65	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
6C2-------------- Arispe	0-7	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	20-30
	7-35	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	45-60	25-35
	35-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
7B, 7C----------- Sharpsburg	0-13	Silt loam--------	CL	A-6	0	100	100	100	95-100	25-40	10-20
	13-37	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	37-45	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	45-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
8B--------------- Macksburg	0-17	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	17-44	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	44-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
9C2, 9D2--------- Higginsville	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	95-100	35-45	15-20
	8-37	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	37-60	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-45	10-20
16B-------------- Ladoga	0-7	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	7-48	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	48-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
16C2------------- Ladoga	0-7	Silty clay loam	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	7-44	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	44-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
23-------------- Bremer	0-19	Silt loam, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
	19-45	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	45-60	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40
26E-------------- Rosendale	0-8	Silty clay loam	CL	A-4, A-6	0-5	95-100	95-100	90-100	80-100	30-40	8-15
	8-27	Silty clay loam, silty clay.	CL	A-6, A-7	0-5	95-100	95-100	95-100	85-100	30-45	11-20
	27-55	Shaly silty clay, silty clay, silty clay loam.	CL, GC, SC	A-7	0-10	55-80	50-75	50-75	45-75	40-50	20-25
	55-70	Weathered bedrock	---	---	---	---	---	---	---	---	---
29F-------------- Brussels	0-6	Very flaggy silty clay loam.	CL	A-6, A-7	45-60	90-100	85-100	75-100	70-95	30-45	15-25
	6-26	Very flaggy silty clay, very flaggy silty clay loam.	CL	A-7	45-65	90-100	85-100	75-100	70-95	40-50	20-30
	26-60	Extremely flaggy silty clay, extremely flaggy silty clay loam.	CL	A-7	65-80	90-100	85-100	75-100	70-95	40-50	20-30
33C-------------- Armstrong	0-7	Silt loam--------	CL, CL-ML	A-6, A-4	0-5	90-100	80-95	75-90	55-80	20-30	5-15
	7-42	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-70	20-35
	42-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
33D2------------- Armstrong	0-7	Clay loam--------	CL	A-6, A-7	0-5	90-100	80-95	75-90	55-80	35-45	15-25
	7-49	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-70	20-35
	49-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
36C-------------- Olmitz	0-21	Loam, clay loam.	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	21-60	Clay loam--------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
37D, 37E--------- Gara	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	10-50	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	50-70	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
42C2------------- Lamoni	0-10	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	10-38	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	38-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
42D2------------- Lamoni	0-7	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	7-41	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	41-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
44D-------------- Shelby	0-9	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	9-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
53B-------------- Judson	0-7	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-35	5-15
	7-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
55A-------------- Colo	0-16	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	16-39	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	39-66	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
56--------------- Zook	0-15	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	15-49	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
	49-60	Silty clay loam, silty clay, silt loam.	CH, CL	A-7, A-6	0	100	100	95-100	95-100	35-80	10-50
58--------------- Wabash	0-6	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	6-66	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
61--------------- Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
71--------------- Albaton	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	7-39	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	39-60	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-60	20-35
72--------------- Haynie	0-9	Very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	9-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
76--------------- Leta	0-11	Silty clay-------	CL, CH	A-7	0	100	100	95-100	95-100	45-65	30-45
	11-27	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-65	20-40
	27-60	Stratified silt loam to sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	80-100	51-95	20-35	5-15
80--------------- Sarpy	0-7	Loamy fine sand	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	7-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
99*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
1B--------------- Marshall	0-8	25-27	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Low----------	0.32	5	6	3-4
	8-60	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
1C2, 1D2--------- Marshall	0-7	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	2-3
	7-49	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	49-65	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
2C--------------- Knox	0-7	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	1-3
	7-42	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	42-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
2D2, 2E2--------- Knox	0-5	27-30	1.20-1.30	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.32	5	6	1-3
	5-44	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	44-70	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
2F2-------------- Knox	0-4	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	1-3
	4-19	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	19-65	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
6C2-------------- Arispe	0-7	28-38	1.35-1.40	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.32	3	7	2-3
	7-35	35-42	1.35-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High---------	0.43			
	35-60	24-35	1.40-1.50	0.6-2.0	0.18-0.20	6.6-7.3	High---------	0.43			
7B, 7C----------- Sharpsburg	0-13	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	6	3-4
	13-37	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	37-45	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	45-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
8B--------------- Macksburg	0-17	25-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	3-4
	17-44	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	High---------	0.43			
	44-60	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
9C2, 9D2--------- Higginsville	0-8	27-30	1.30-1.40	0.6-2.0	0.20-0.23	5.6-7.3	Moderate-----	0.37	4	6	2-3
	8-37	27-35	1.40-1.50	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.37			
	37-60	25-30	1.50-1.60	0.6-2.0	0.18-0.22	5.1-6.5	Moderate-----	0.37			
16B-------------- Ladoga	0-7	18-35	1.30-1.35	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.32	5	6	2-3
	7-48	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	48-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
16C2------------- Ladoga	0-7	18-35	1.30-1.35	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.32	5	6	2-3
	7-44	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	44-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
23--------------- Bremer	0-19	25-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	3-5
	19-45	35-42	1.30-1.40	0.2-0.6	0.15-0.17	5.6-6.5	High---------	0.28			
	45-60	32-38	1.40-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High---------	0.28			
26E-------------- Rosendale	0-8	24-36	1.30-1.40	0.2-0.6	0.20-0.24	5.6-7.3	Moderate-----	0.32	4	6	1-3
	8-27	27-42	1.30-1.40	0.2-0.6	0.13-0.20	5.6-7.3	Moderate-----	0.32			
	27-55	35-48	1.25-1.35	0.06-0.2	0.07-0.11	7.4-8.4	High---------	0.32			
	55-70	---	---	---	---	---	-------------	----			
29F-------------- Brussels	0-6	27-40	1.30-1.50	0.2-0.6	0.09-0.14	6.1-7.8	Moderate-----	0.15	2	8	2-4
	6-26	35-50	1.35-1.55	0.2-0.6	0.06-0.12	6.1-7.8	Moderate-----	0.20			
	26-60	35-50	1.35-1.55	0.2-0.6	0.02-0.06	6.1-7.8	Moderate-----	0.20			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
33C-------------- Armstrong	0-7	22-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	3	6	2-3
	7-42	36-60	1.45-1.55	0.06-0.2	0.11-0.16	4.5-7.3	High---------	0.32			
	42-60	30-36	1.55-1.70	0.2-0.6	0.14-0.16	5.1-8.4	Moderate-----	0.32			
33D2------------- Armstrong	0-7	27-38	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.32	2	6	1-2
	7-49	36-60	1.45-1.55	0.06-0.2	0.11-0.16	4.5-7.3	High---------	0.32			
	49-60	30-36	1.55-1.70	0.2-0.6	0.14-0.16	5.1-8.4	Moderate-----	0.32			
36C-------------- Olmitz	0-21	24-30	1.40-1.45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	3-4
	21-60	28-34	1.45-1.55	0.6-2.0	0.15-0.17	5.1-6.5	Moderate-----	0.28			
37D, 37E--------- Gara	0-10	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	2-3
	10-50	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	50-70	24-38	1.65-1.75	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
42C2------------- Lamoni	0-10	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	6	2-3
	10-38	38-50	1.55-1.65	0.06-0.2	0.13-0.17	5.1-6.5	High---------	0.32			
	38-60	32-40	1.60-1.70	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.32			
42D2------------- Lamoni	0-7	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	6	2-3
	7-41	38-50	1.55-1.65	<0.2	0.13-0.17	5.1-6.5	High---------	0.32			
	41-60	32-40	1.60-1.70	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.32			
44D-------------- Shelby	0-9	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.28	5	6	3-4
	9-45	30-35	1.55-1.65	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	45-60	30-35	1.55-1.65	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
53B-------------- Judson	0-7	24-27	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Low----------	0.28	5	6	4-5
	7-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43			
55A-------------- Colo	0-16	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	5-7
	16-39	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28			
	39-66	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.28			
56--------------- Zook	0-15	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	15-49	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
	49-60	20-45	1.30-1.45	0.06-0.6	0.11-0.22	5.6-7.8	High---------	0.28			
58--------------- Wabash	0-6	40-46	1.25-1.45	<0.06	0.12-0.14	5.6-7.3	Very high----	0.28	5	4	2-4
	6-66	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	Very high----	0.28			
61--------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	2-3
71--------------- Albaton	0-7	40-60	1.35-1.40	.06-0.2	0.11-0.13	7.4-8.4	High---------	0.28	5	4	2-3
	7-39	40-60	1.35-1.45	.06-0.2	0.11-0.13	7.4-8.4	High---------	0.28			
	39-60	30-40	1.30-1.40	0.2-0.6	0.18-0.20	7.4-8.4	Moderate-----	0.28			
72--------------- Haynie	0-9	15-25	1.20-1.35	0.6-2.0	0.18-0.23	6.6-8.4	Low----------	0.37	5	4L	2-3
	9-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	Low----------	0.37			
76--------------- Leta	0-11	40-48	1.30-1.50	0.06-0.2	0.12-0.14	6.6-7.8	High---------	0.28	5	4	2-4
	11-27	45-60	1.30-1.50	0.06-0.2	0.11-0.19	7.4-7.8	High---------	0.28			
	27-60	10-27	1.30-1.50	0.6-2.0	0.14-0.22	7.4-8.4	Low----------	0.28			
80--------------- Sarpy	0-7	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	Low----------	0.15	5	2	<1
	7-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	Low----------	0.15			
99*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the
< means less than; > means more than. Absence of an entry indicates that the feature is not a concern or
estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			In		
1B, 1C2, 1D2------ Marshall	B	None--------	---	---	>6.0	---	---	>60	---	High-----
2C, 2D2, 2E2, 2F2- Knox	B	None--------	---	---	>6.0	---	---	>60	---	High-----
6C2-------------- Arispe	C	None--------	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	High-----
7B, 7C----------- Sharpsburg	B	None--------	---	---	>6.0	---	---	>60	---	High-----
8B--------------- Macksburg	B	None--------	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	High-----
9C2, 9D2--------- Higginsville	C	None--------	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High-----
16B, 16C2-------- Ladoga	B	None--------	---	---	>6.0	---	---	>60	---	Moderate
23--------------- Bremer	C	Rare--------	---	---	1.0-2.0	Apparent	Nov-Apr	>60	---	High-----
26E-------------- Rosendale	C	None--------	---	---	3.0-5.0	Perched	Nov-Apr	40-60	Soft	Moderate
29F-------------- Brussels	C	None--------	---	---	>6.0	---	---	>60	---	Moderate
33C, 33D2-------- Armstrong	C	None--------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	High-----
36C-------------- Olmitz	B	None--------	---	---	>6.0	---	---	>60	---	Moderate
37D, 37E--------- Gara	C	None--------	---	---	>6.0	---	---	>60	---	Moderate
42C2, 42D2------- Lamoni	C	None--------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	Moderate
44D-------------- Shelby	B	None--------	---	---	>6.0	---	---	>60	---	Moderate

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			In		
53B------------ Judson	B	None--------	---	---	>6.0	---	---	>60	---	High-----
55A------------ Colo	B/D	Occasional	Very brief to long.	Nov-May	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----
56------------- Zook	C/D	Occasional	Brief to long.	Nov-May	0-3.0	Apparent	Nov-Apr	>60	---	High-----
58------------- Wabash	D	Occasional	Brief to long.	Nov-May	0-1.0	Apparent	Nov-Apr	>60	---	Moderate
61------------- Nodaway	B	Occasional	Very brief to brief.	Nov-May	3.0-5.0	Apparent	Nov-Apr	>60	---	High-----
71------------- Albaton	D	Rare--------	---	---	1.0-3.0	Apparent	Nov-Apr	>60	---	Moderate
72------------- Haynie	B	Rare--------	---	---	>6.0	---	---	>60	---	High-----
76------------- Leta	C	Rare--------	---	---	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----
80------------- Sarpy	A	Rare--------	---	---	>6.0	---	---	>60	---	Low------
99*. Pits										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Albaton	Fine, montmorillonitic (calcareous), mesic Vertic Fluvaquents
*Arispe	Fine, montmorillonitic, mesic Aquic Argiudolls
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
Brussels	Clayey-skeletal, mixed, mesic Typic Hapludolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
*Higginsville	Fine-silty, mixed, mesic Aquic Argiudolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Knox	Fine-silty, mixed, mesic Mollic Hapludalfs
Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Leta	Clayey over loamy, montmorillonitic, mesic Fluvaquentic Hapludolls
Macksburg	Fine, montmorillonitic, mesic Aquic Argiudolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Rosendale	Fine, mixed, mesic Typic Eutrochrepts
Sarpy	Mixed, mesic Typic Udipsamments
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

*U.S. G.P.O. 1990-262-945:20002/SCS

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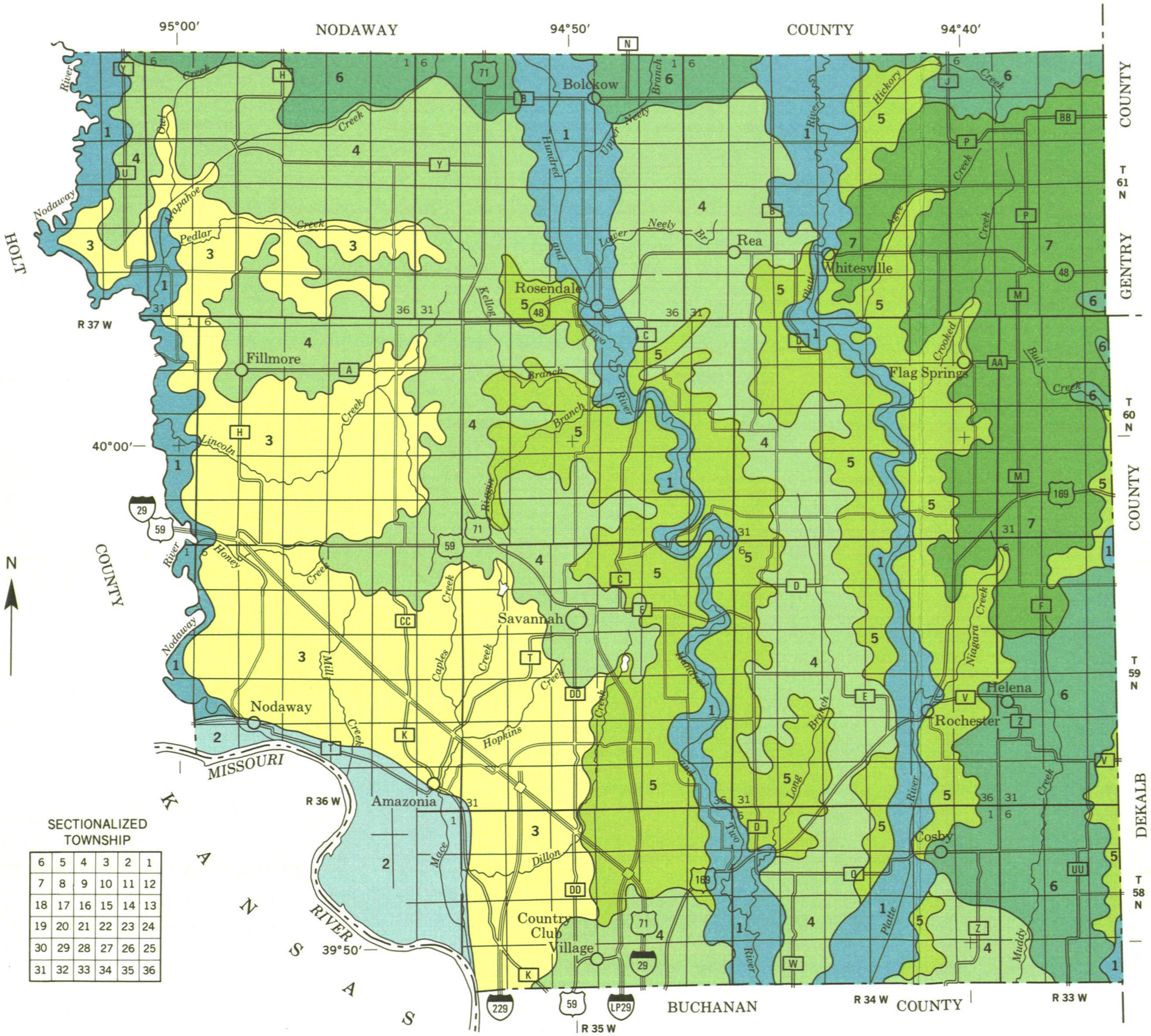


6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

LEGEND

1 Nodaway-Colo-Zook association: Nearly level, moderately well drained and poorly drained soils formed in alluvium; on intermediate flood plains

2 Leta-Haynie association: Nearly level, somewhat poorly drained and well drained soils formed in alluvium; on flood plains along the Missouri River

3 Knox-Brussels association: Moderately sloping to very steep, well drained soils formed in loess and colluvium; on uplands

4 Marshall-Lamoni-Higginsville association: Gently sloping to strongly sloping, well drained and somewhat poorly drained soils formed in glacial till and loess; on uplands

5 Knox-Gara-Armstrong association: Moderately sloping to moderately steep, well drained to somewhat poorly drained soils formed in glacial till and loess; on uplands

6 Lamoni-Sharpsburg-Shelby association: Gently sloping to strongly sloping, somewhat poorly drained to well drained soils formed in glacial till and loess; on uplands

7 Arispe-Macksburg-Lamoni association: Gently sloping and moderately sloping, somewhat poorly drained soils formed in loess and glacial till; on uplands

Compiled 1988

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISSOURI AGRICULTURAL EXPERIMENT STATION

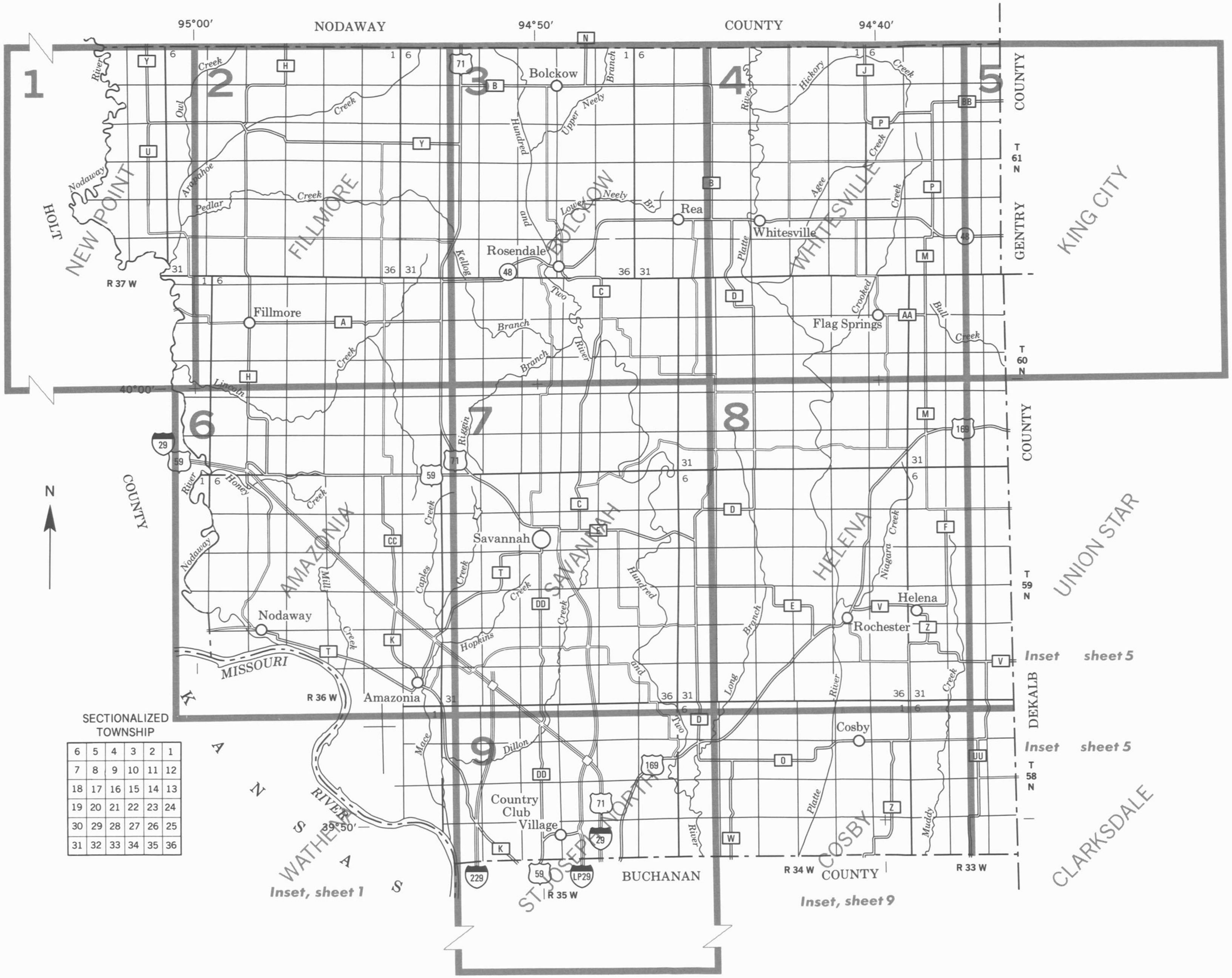
GENERAL SOIL MAP

ANDREW COUNTY, MISSOURI

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km



INDEX TO MAP SHEETS

ANDREW COUNTY, MISSOURI

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil or miscellaneous area. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or for miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is eroded.

SYMBOL	NAME
1B	Marshall silt loam, 2 to 5 percent slopes
1C2	Marshall silty clay loam, 5 to 9 percent slopes, eroded
1D2	Marshall silty clay loam, 9 to 14 percent slopes, eroded
2C	Knox silt loam, 5 to 9 percent slopes
2D2	Knox silty clay loam, 9 to 14 percent slopes, eroded
2E2	Knox silty clay loam, 14 to 20 percent slopes, eroded
2F2	Knox silt loam, 20 to 35 percent slopes, eroded
6C2	Arispe silty clay loam, 5 to 9 percent slopes, eroded
7B	Sharpsburg silt loam, 2 to 5 percent slopes
7C	Sharpsburg silt loam, 5 to 9 percent slopes
8B	Macksburg silty clay loam, 2 to 5 percent slopes
9C2	Higginsville silty clay loam, 5 to 9 percent slopes, eroded
9D2	Higginsville silty clay loam, 9 to 14 percent slopes, eroded
16B	Ladoga silt loam, 2 to 5 percent slopes
16C2	Ladoga silty clay loam, 5 to 9 percent slopes, eroded
23	Bremer silt loam
26E	Rosendale silty clay loam, 9 to 30 percent slopes
29F	Brussels very flaggy silty clay loam, 14 to 50 percent slopes
33C	Armstrong silt loam, 5 to 9 percent slopes
33D2	Armstrong clay loam, 9 to 14 percent slopes, eroded
36C	Olmitz loam, 3 to 9 percent slopes
37D	Gara loam, 9 to 14 percent slopes
37E	Gara loam, 14 to 20 percent slopes
42C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded
42D2	Lamoni clay loam, 9 to 14 percent slopes, eroded
44D	Shelby loam, 9 to 14 percent slopes
53B	Judson silt loam, 2 to 7 percent slopes
55A	Colo silty clay loam, 0 to 3 percent slopes
56	Zook silty clay loam
58	Wabash silty clay
61	Nodaway silt loam
71	Albaton silty clay
72	Haynie very fine sandy loam
76	Leta silty clay
80	Sarpy loamy fine sand
99	Pits, quarries

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Swift Airport; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 8B 7C

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

This soil survey map was compiled by the U.S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U.S. Department of the Interior, Geological Survey, from 1974 - 1980 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 3/4 1/2 1/4 0 1 2 MILES

1 0.5 0 1 2 KILOMETERS

SCALE 1:24 000

N

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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
SCALE 1:24 000

N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NUMBER 3
ANDREW COUNTY, MISSOURI
(BOLCKOW SOUTHEAST QUADRANGLE)

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1 3/4 1/2 1/4 0 1 2 MILES

1 0.5 0 1 2 KILOMETERS

SCALE 1:24 000

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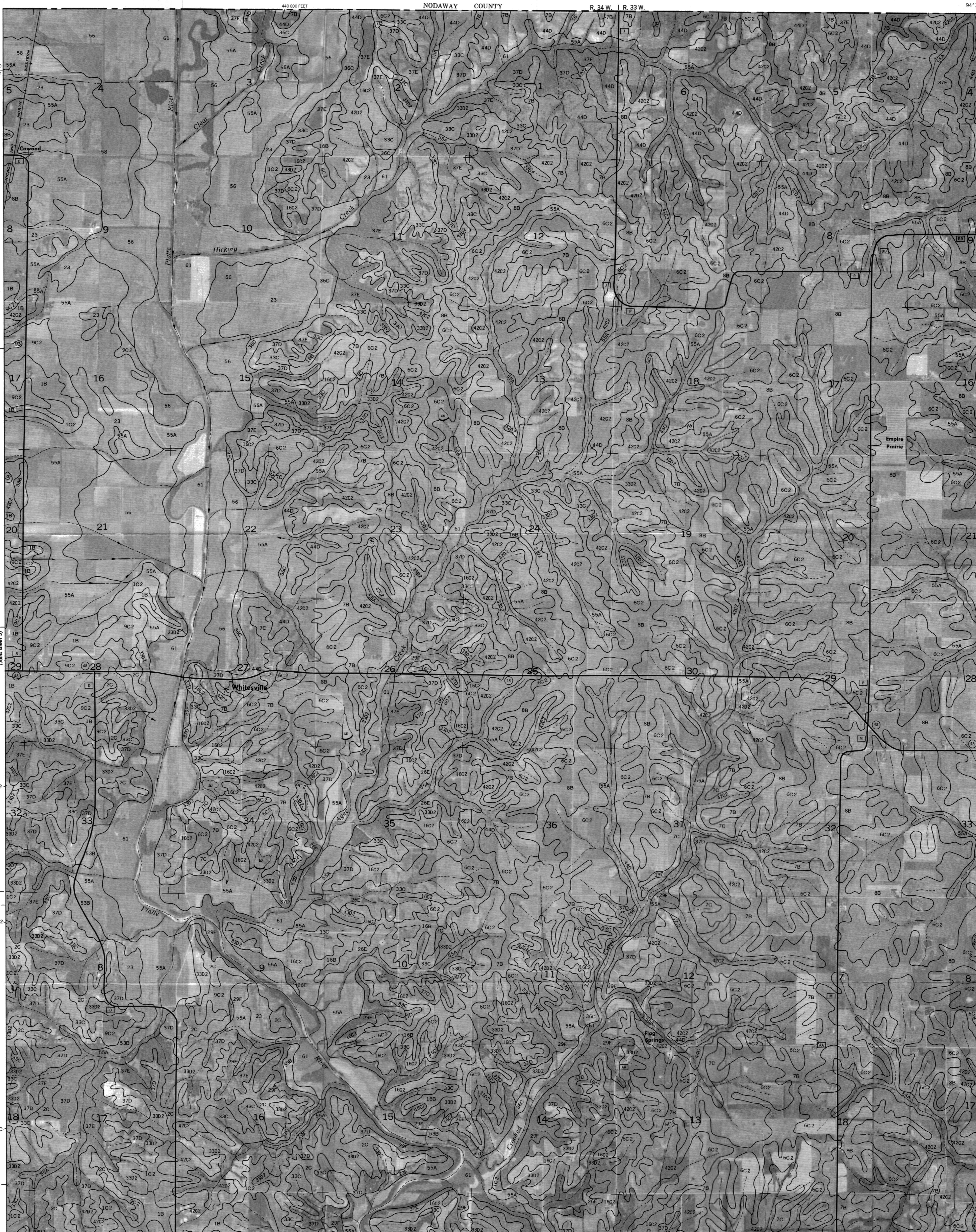
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NUMBER 4
ANDREW COUNTY, MISSOURI
(STANBERRY SOUTHWEST QUADRANGLE)



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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
SCALE 1:24 000

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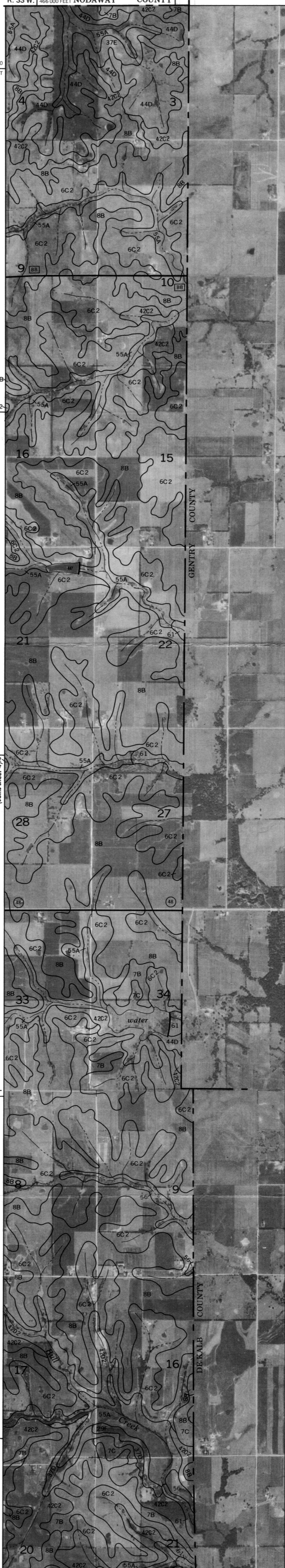
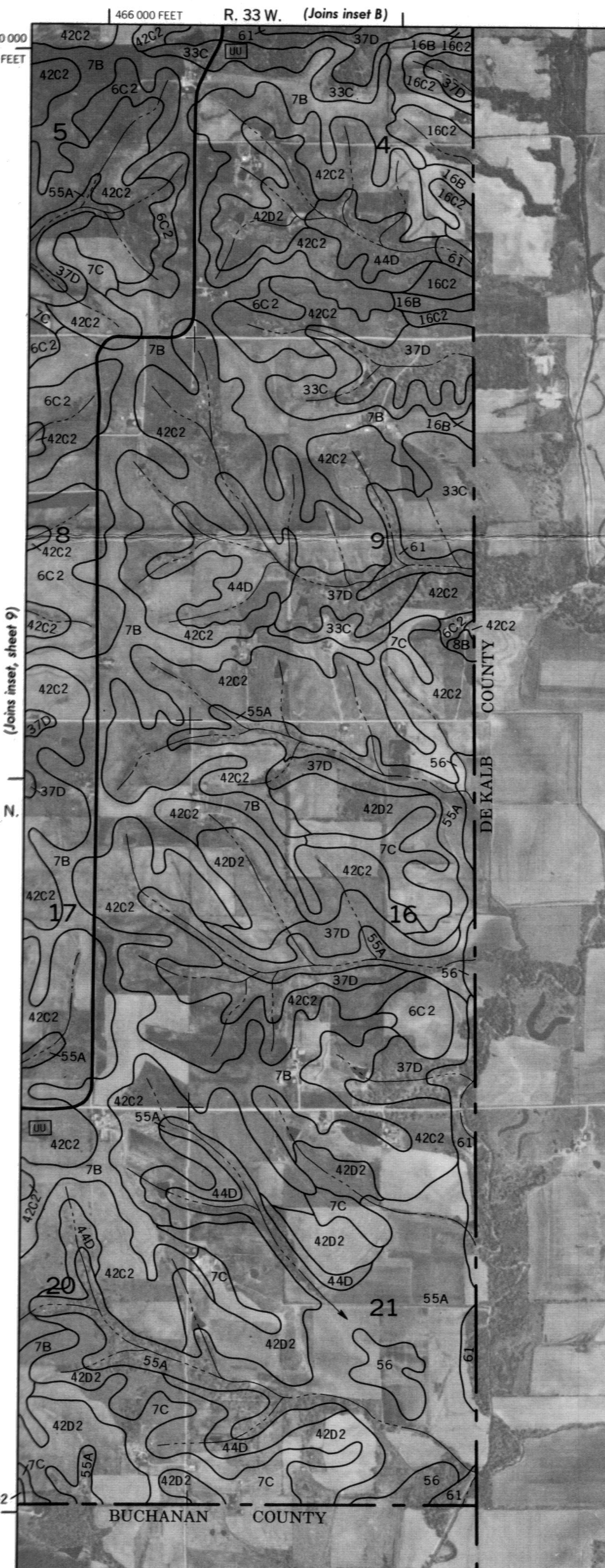
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NUMBER 5
ANDREW COUNTY, MISSOURI
(STANBERRY SOUTHEAST QUADRANGLE)



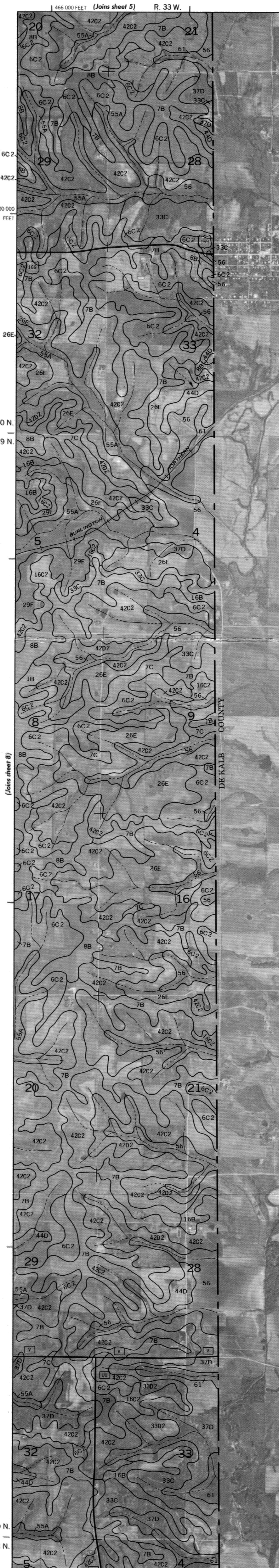
4000 AND 10000-FOOT GRID TICKS

INSET A



4000 AND 10000-FOOT GRID TICKS

INSET B



4000 AND 10000-FOOT GRID TICKS

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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
SCALE 1:24 000

N

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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
SCALE 1:24 000

N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NUMBER 7
ANDREW COUNTY, MISSOURI
(SAVANNAH QUADRANGLE)

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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
SCALE 1:24 000

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SCALE 1:24 000

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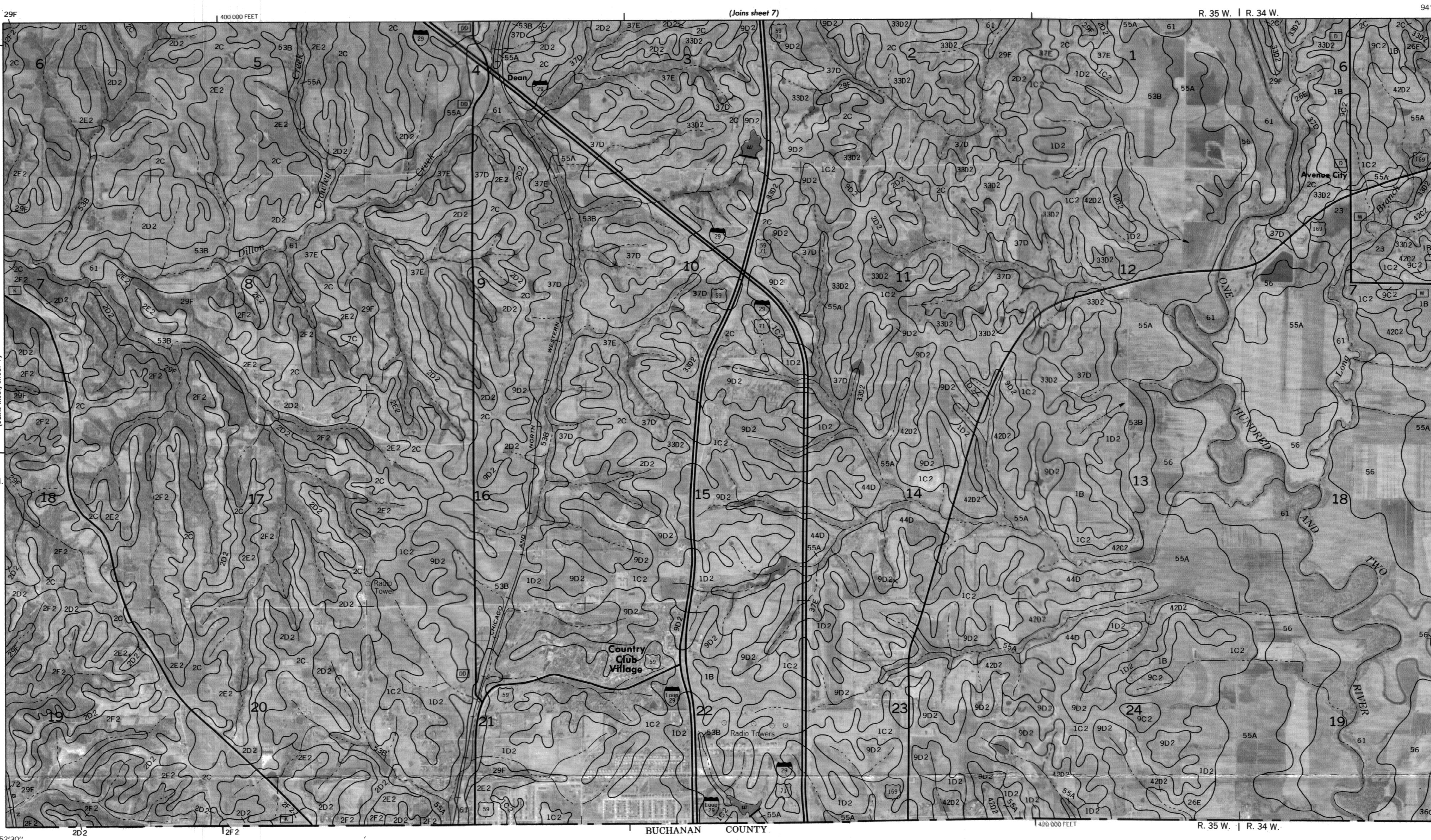

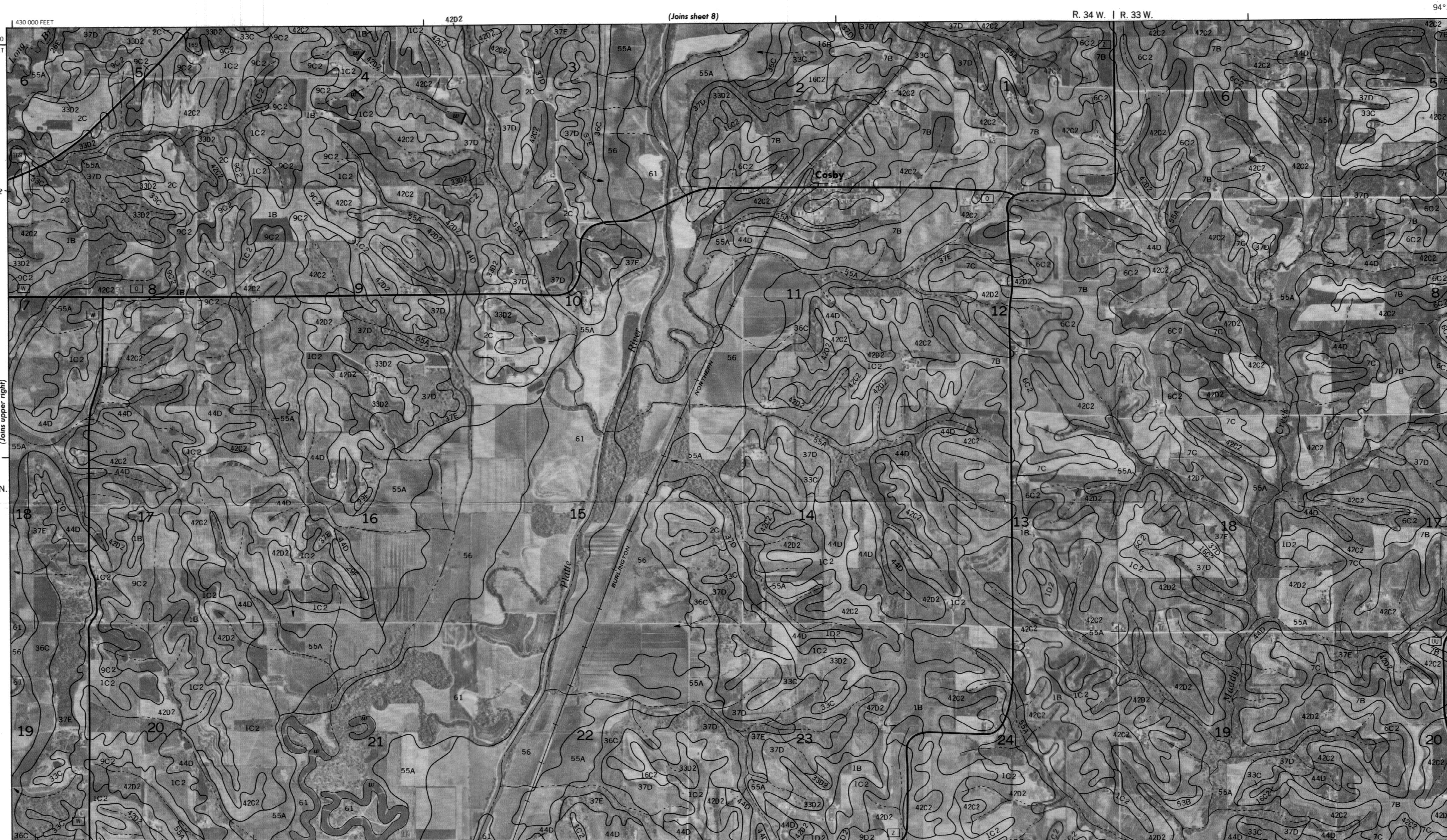

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1 3/4 1/2 1/4 0 1 2 MILES
1 0.5 0 1 2 KILOMETERS
SCALE 1:24 000

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